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MINING AND METALLURGY IN NEGRO AFRICA

By

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TO

ELEANOR AND DOUGLAS OLIVER

PREFACE

The rage for psychology and sociology which has affected anthropology within the last fifteen years has brought, among numerous blessings, two very insidious evils. At a time when the coordination of archaeology and ethnology was beginning to be most productive, this new trend has widened the gap between the two disciplines, and has convinced many younger spirits that the fields of historical research which anthropology has only begun to clear and cultivate have already been exhausted.

Furthermore, it has encouraged an indifference to literature — not only to the professional literature of anthropology, but to the more naive and often more honest sources in early geography and travels. Young anthropologists are not bookish enough anyway; they want to go on trips. They naturally welcome the suggestion that the existing data are not good enough to use, and that what we really need is "original field work." This assumption is largely true. But a field job in ethnology almost invariably produces an account of one particular culture. It seldom illuminates a large set of cultures or a broad area; and the modern tendency to use less and less "comparative material" — a wholesome reaction against the old-style ethnology which leaped over five continents in a single page — is retarding our progress very badly. It offers us little between the meticulous description of a single society, and generalizations which are so broad — I almost said so obvious — that they might just as well be obtained in Newburyport as in Bobo-Julasso.

A student of Negro Africa is particularly aware both of archaeology and of the literature, but for opposite reasons: he has so little archaeology and so much literature. No anthropologist who does not specialize in Africa can name half a dozen excavated sites south of the Sahara — except the Palaeolithic ones — and I doubt that most Africanists could name more than twenty. But take a walk through the African section of any of the largest libraries, and you will find enough printed matter about Negroes to keep you busy for years — if you were foolish enough to read indiscriminately from such uneven material. Very little of this has been written by anthropologists; some of the best, as well as some of the worst, has been written by missionaries; and most of it has been produced in the authors' spare time. One curious trait runs through most of it: the writer seems neither to know nor to care about any other part of Africa than the one in which he is located.

In the following pages I have tried to bring together all the data on mining and metallurgy which I could find in this bulky literature, to generalize as far as I safely can, and to urge the need for more observation and research, especially in Negro archaeology. The job has been mainly a bibliographic one. It reaches a point of departure for the direct study which must be undertaken in laboratories and museums and in Negro Africa — studies which alone can give us real conclusions.

The reader will notice — perhaps with some disappointment — that I have refrained from a serious discussion of origins. The most exhaustive archaeological and metallurgical research will never be able to demonstrate the indigenous discovery of metals or their first importation to Negro Africa. Such research will undoubtedly swing the balance of probability either toward diffusion or independent invention, but the existing information is not enough to do so.

Even in a bibliographic way my work is far from complete. Many notes undoubtedly lie in libraries and museum archives abroad, and I could read travel books for another five years and still pick up an occasional reference to Negro metallurgy. But labor of this kind gives diminishing returns. The important thing is to produce a work of sufficient volume and quality to serve those who will study the actual material, or those who desire a general view of the subject as it is known to date.

Ethnologists will cavil at my spelling of African names, and look on my map in vain for many tribes and localities mentioned in the text. In the present state of African literature, however, to remedy either of these defects would necessitate a special research project.

On the technological side I trust that I have made no major blunders. I cry for no mercy from the metallurgists; but I have so far found them personally most encouraging, Mr. Michael Yatsevitch and Dr. L.R. van Wert having already read parts of the manuscript and straightened out several difficult places. I am deeply obliged to them for past and future suggestions, as well as to Dr. E. A. Hooton, who has read and discussed the paper with me, and whose friendly encouragement has lightened the labor of completing it for an academic deadline.

The footnotes and maps need a word of explanation. All the numbers in parenthesis in the text refer to the books and articles listed numerically in the bibliography at the end of the volume. Those which are re-

peated at the bottom of the page refer to books, the page or pages in the book being indicated by the numbers following. I have not given page references to articles except in the bibliography itself.

The general map is still growing. I have not renumbered the tribes and localities on it to make them more easily found, for I have been inserting newly found locations up to the last minute. The map is preceded by a legend on which the locations are listed numerically under the sections into which the map is divided.

Walter Cline

London, 1936

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MINING AND METALLURGY IN NEGRO AFRICA

I. GOLD AND SILVER

GOLD

It is curious that the metal most active in drawing the attention of the Arab and European worlds to Negro Africa was the one which the Negroes themselves generally valued the least; still more curious, perhaps, that I should use this metal to introduce Negro mining and metallurgy. I do so for two reasons. First, a review of gold will provide us with an historical background of foreign contacts, the agents of which were notoriously metal-minded; secondly, because it is convenient to get a minor and somewhat separate subject out of the way before we go on to the essential parts of the metallurgical complex.

Gold flowed out from the Negro borderlands in very ancient times. Much of the gold in Egypt, as early as the Sixth Dynasty, came down from the Upper Nile (40);[1] and the Somali coast is commonly identified with the famous Punt, whence gold and other precious substances came to Egypt. But it was not until the Middle Ages that the gold trade from the real Negro area assumed any great volume.

West Africa: Gold in the Past

In the year 1324 the Mandingo emperor of Mali, Mansa Musa, made the pilgrimage to Mecca (194). He was not the first Negro monarch to accomplish this rite, for a sultan of Tekrur in the eleventh century and another in the thirteenth had both performed it — the latter, four times (194). But Musa's pious journey did more than the others for the relations of Negro cultures with Arab. He brought back with him one Abu Ishaq es Sahili, surnamed the Little Saucepan, a scholar and poet of Granada, whom he had met in the Holy City, and who built the first brick mosques at Gao and Timbuktu (102),[2] where Ibn Battuta viewed his tomb with reverence a generation later (17).[3] While in Cairo the Mansa was entertained as an equal in the highest society, who were astonished to learn that though this "young man of brown color" had conquered twenty-four cities and ruled fourteen kingdoms and provinces, his own Muslim domains, compared with those of the pagan Negroes, were like a small white spot on the skin of a black cow, (194).[4] Maqrizi (194), writing seventy-five years after this visit, says that Musa brought ten thousand of his subjects with him, and that they all spent so much gold on the bad merchandise offered them in Cairo that the value of the gold dinar on the Cairo exchange dropped to six dirhems. 'Omari (194), less prone to Semitic exaggeration, claims that it fell from twenty-five dirhems and above to twenty-three and less. Whichever quotation we choose, the Mansa spent more than was wise; for on his way back he had to borrow money from a Cairo merchant, who later crossed the Sahara to collect the debt and died in Timbuktu in the house of the Little Saucepan (17).[5]

We could follow a score of medieval tales of the Western Sudan, but most of them would lead us to a single end, its inexhaustible supply of gold. Mansa Musa told the credulous Cairenes — or perhaps, for reasons best known to himself, simply assented to their belief — that Mali obtained its gold not from normal mines within its boundaries, but from two kinds of plants which grew in pagan territory (194). One of these plants appeared in the desert after the spring rains. It had leaves like those of the najil — an herb related to the camel forrage called ḥamd — and roots of native gold. The other flourished all the year round at certain places on the banks of the Niger, and had gold roots in the form of stones and gravel, which were less valued than those of the other plant.

This rumor of vegetable gold in the Sudan had apparently been circulating among the Arabs for a long time. It accords with a medieval Arab conception that the roots of plants are related to minerals, both being products of the earth (57). Says Ibn el Faqih (194), in the tenth century, "It is in the country of Ghana that one makes in the sand plantations of gold, as one plants carrots; one harvests it at break of day.' Yaqut (194),[6] at the beginning of the thirteenth century, cites the same tradition. 'Omari, who gives us our best account of Mansa Musa's Egyptian visit, says in another of his books (194) that the gold begins to sprout in the latter part of the Syriac month Tammuz and the first part of Ab — corresponding to our August — when the sun is strongest and the Niger begins to rise. When the sun's heat and the Niger waters abate, the Negroes hunt for gold wherever the flood-water has covered the ground. This, in conjunction with the remarks of Mungo Park, suggests an explanation for the story.

1. 40: p. 94.
2. 102: pp. 377-83.
3. 17: Vol. 4, pp. 427, 431.
4. 194: pp. 70, 75-79, 89-92.
5. 17: Vol. 4, pp. 431-32.
6. 194: p. 71 footnote; pp. 70-72, with footnotes.

"About the beginning of December," says Park (200),[7] "when the harvest is over, and the streams and torrents have greatly subsided, the Mansa, or chief of the town, appoints a day to begin 'gold washing'." The flood of the river, redistributing the auriferous earth, has started this washing process and has carried more pay dirt down from the hills. What more natural than to attribute the newly exposed gold to a plant-like growth induced by the waters?

If the reader can abide a few more odd tales and light conjectures, in a paper which promises much material of a more soporific kind, he may bear a little longer with our gullible old Arabs. Mansa Musa had apparently not done his best to make Muslims of the black barbarians on his frontiers, but he had a good excuse ready for his pious and gold-loving hosts at Cairo. He told them (194)[8] that he had learned by sad experience that when he had conquered one of those pagan groups and had established Islam among them, with the call to prayer, their harvest of gold dwindled away to nothing, while it increased among their unconverted neighbors. He therefore left them in possession of their pagan cult and of their gold fields, merely exacting tribute in gold and a certain amount of obedience.

This, in a special Sudan version, is the same old inside story of the finances of the Muslim conquest, and 'Omari must have repeated it with his tongue in his cheek. Unbelievers under Muslim rule had to pay a special tax, which by no stretch of law could be imposed on converts. Once the early Muslims had conquered a land, they usually relaxed their Muhammad-or-the-sword policy for the benefit of the exchequer. Though Mansa Musa told ez Zawawi (194) that he did not oblige his pagan tributaries to pay the infidel tax, he may have found it legally difficult to exact from them any form of tribute after they had joined the Muslim community.

The gold miners, working by special techniques at sources known only to themselves, might also baulk religious interference by simply lying down on their jobs and declaring the crop a failure. Thus the auricultural myth, whether a superstition or a lie, seems to have worked for the benefit of all parties concerned.

I have found no trace of it, however, in modern data on the Western Sudan. Instead, the Mandingo of Senegambia (31),[9] who abandon a gold mine for a few years if it caves in and kills a miner, expect the water infiltrating into cavities left by his decomposing body to bring a rich deposit of gold dust as "the price paid by the devil" for the captive smothered away in the mine.

The medieval history of the Western Sudan could be written largely in terms of gold and salt; sea salt brought to the big towns on the Upper Niger and Senegal from the Atlantic coast, and rock salt from deposits in the Western Sahara, notably at Teghazza. This condiment, owing to its scarcity in the interior of tropical Africa, and possibly to a physiological need for it in climates which cause a great loss of body salt through sweat, has always been greatly craved by Negroes. According to Abu 'Abdallah ibn es Sa'igh, cited by el 'Omari (194),[10] some unscrupulous Moors, in silent trade with the Negroes, exacted a cupfull of gold dust for every cupfull of salt they put out for them. This trade continued into modern times, on a more open and fairer basis. Mungo Park (200) reports large quantities of gold being traded for salt at Kancaba, Kankaree, and other large Mandingo towns.

The Negroes were also eager for the baser metals — especially brass, tin, and copper — since they lacked copper mines of their own and had only a very limited supply of tin — probably from Northern Nigeria. Dimashqi implies (178)[11] that the natives of Ghana would give gold for tin because the latter was rarer — possibly, we suggest, because they needed it for bronze. In Idrisi's time (86)[12] people from the western coast of West Africa were bringing copper and seashells to Tekrur to exchange for gold and slaves.

In the Middle Ages much of the gold flowed northward across the Western Sahara to the great emporium of Sijilmassa, which had become Morocco's main port to the Sudan as early as the eighth century, and was destined to hold this position until the sixteenth (102).[13]

The chief source of gold both for Ghana and Mali seems to have been the region now called Bambuk, between the Rivers Bafing and Faleme, tributaries of the Senegal (222).[14] In their upper courses these streams flow very near each other, giving rise to the medieval idea that this region was an island in the Nile (86) — the Insula Tiber of fifteenth century maps, from the Arabic tibr, meaning gold dust. Idrisi (86) describes the gold-bearing country as a large island in the Nile, eight days from Ghana, and calls it Wangara, a name later applied probably to Mandingo traders, the Wanjarate of Arab accounts (17).[15] He says that at one season of the year it is partially flooded, and that the natives collect the gold dust after the floods have abated. El Bekri (25)[16] reports that Kugha, which Idrisi (86)[17] identifies as a dependency of Wangara, was especially productive of gold dust, that the best gold of Ghana came from the city of Ghayaru, and that the Banu Taghmarta were

7. 200: pp. 299-300.
8. 194: p. 71, footnote; pp. 58-59.
9. 31: pp. 205-206.
10. 194: p. 81.
11. 178: p. clxxxviii.
12. 86: pp. 12, 8.
13. 102: pp. 377 ff.
14. 222: Vol. 1, pp. 90, 94; Vol. 3, pp. 1, 57.
15. 17: Vol. 4, p. 394.
16. 25: pp. 331, 335.
17. 86: pp. 18, 21.

the chief agents of its export. The later kingdom of Mali owed its commercial importance to its situation at the entrance to valleys leading to these gold fields and those of the neighboring district of Bouré.

It is difficult to locate precisely the gold source referred to by Ibn Battuta (17)[18] as the home of the cannibals who visited the king of Mali. Delafosse (72)[19] suggests that this was Bouré. The mention of cannibalism should help us, for this habit is not common in this part of West Africa. Park (200) says that the Bambara attribute cannibalism to the people of Maniana, west of Baedoo, southeast of the island kingdom of Jinbala, and he himself believed them.

At any rate, the same sources have been worked by natives within recent years. Park found gold plentiful in all parts of the Mandingo territory, especially in the fertile, hilly country around Bouré (200),[20] four days southwest of Kamalia. To Bouré came Negro merchants from the Atlantic coast and Moors from the desert, all bringing salt to barter for gold. The gold of Bambougou (Satadougou) and that of Bouré (Siguiri), both worked by modern jewelers in Fouta, are distinguished by their shades: the former being "white," the latter "yellow."

Though the Arabs probably never worked the actual mines, perhaps never even saw them, they dazzle us with the abundant gold which they claim to have found amongst the Negroes. El Bekri (25),[21] who gives the most lavish accounts of gold furnishings at the court of Ghana, says that the king of Ghana monopolized all nuggets, allowing his subjects to keep only the dust, lest gold become a base metal. Idrisi (86),[22] nearly a century later, credited the Ghana sovereign with a nugget weighing thirty pounds. This rivalled the famous piece which was large enough for the king to tether his horse to, and which was sold by the sultan Mari Dyata of Mali in the middle of the fourteenth century (194).[23]

Christian countries did not remain deaf to such rumors, and with the rise of the great trading cities of Italy and the birth of the Portuguese Empire, they began to claim a share in Negro trade. The Atlas of Abraham Cresques, executed in about the year 1375, bears inscriptions referring to the voyage of Jaime Ferrer in search of the gold of Mandinga and Rio de Ouro (222):[24] and when, in the early fifteenth century, Prince Henry the Navigator looked southward from his geographic laboratory at Cape St. Vincent — the Land's End of all Europe — he hoped not only to check the progress of Islam in West Africa and to save Negro souls, but to draw toward Portugal the gold dust of Guinea which the Arabs had theretofore controlled.

The times were ripe for such ambitions. After the Hundred Years War a severe economic depression had reduced the financial systems of Europe to chaos (222). Benedetto Centurione, a banker of Genoa — one of the family for whom Columbus sailed — wished to stabilize Genoese currency on the gold standard, but needed more gold. Having heard of the sources in the Sahara and Sudan, the Centurione in 1447 sent down one Antonio Malfante, with orders to study them. He got no farther than the oasis of Tuat, where the people told him that the gold was obtained by silent trade from the Negroes of Bambuk. While in Mauretania in 1455, Alvise de Ca Da Mosto (222) heard the same, and learned the routes by which gold flowed from the Sudan: from Koukiya near Gao to Egypt; by way of Tuat to Tunis; by way of Wadan in Mauretania to Morocco. In exchange for gold the Negroes received mainly salt, sea-shells, copper, and fancy cloth. Twenty-three years after Malfante's mission, Benedetto Dei reached Timbuktu in the interests of the Florentine family of Portinari — kinsmen of Dante's Beatrice — who traded in Lombardy fabrics and were seeking to sell them for gold (222).[25]

The arrival of the Portuguese traders on the coast, heralded by the establishment of a fortress at Arguin in 1445, shifted the gold trade from north to west, Moors bringing slaves and gold to Arguin to trade for clothing and grain (222). Before long the Portuguese set up fortified trading stations along the coast further south, monopolizing — as recognized by their treaty with Spain in 1479 — the trade with the Negro tribes in brass, sea-shells, and cloth in return for slaves and gold.

Sometimes this trade brought the baser metals, for which the Negroes undoubtedly gave a very good bargain. In 1505 (178) the Portuguese at the trading fortress of Elmina on the Atlantic coast, were giving brass and copper bracelets for gold brought from the interior; and Dapper (63), in the seventeenth century, relates that iron was traded for gold to the natives on the Gambia.

West Africa: Modern Distribution, Mining, and Techniques

In spite of this grand history, goldworking now has a rather spotty distribution in West Africa. The Agni (70), Dagomba (38),[26] Ashanti (38), Baoulé (119), Mandingo at Kamalia (200),[27] Fula (31), the people of Fouta (84), and undoubtedly other groups, have all practised it within recent times, but there are several surprising gaps. James Welsh

18. 17: Vol. 4, pp. 428-29.
19. 72: Vol. 2, p. 202.
20. 200: pp. 299, 217.
21. 25: pp. 329-31.
22. 86: p. 16.
23. 194: p. 71, footnote.
24. 222: Vol. 1, pp. 122-26, 128, 136; Vol. 3, pp. 1, 23, 28; plates 11 and 24.
25. 222: Vol. 1, pp. 49, 97, 146, 160; Vol. 2, pp. 26-27, etc.
26. 38: pp. 311-12.
27. 200: p. 285.

(178), an English trader at Benin between 1588 and 1591, saw no gold or silver there; and in Yatenga, between the bend of the Niger and the hinterland of Ashanti (264), gold is almost unknown, though copper and silver were got by trade before the French occupation of the district. As trade with the outside world increased, the drain on the sources of gold dust seems to have become so constant that most gold left Negro hands before they could fashion it. This is explicitly stated for the Lobi (52), who do not work the precious dust which they collect because it is too valuable as an article of trade.

West Africans have probably collected the gold only by the most primitive mining and washing methods. The panning of surface gravels seems to have predominated. Here and there, however, we find references to mining in pits and shafts. 'Omari (194)[28] states that the Mali natives mined gold in holes as deep as a man was tall; while Himmelheber (119) tells me that some of the Baoulé mines, where men do the actual digging and women the panning, run as deep as seventy metres; and Joseph (135) writes that they reach a depth of seventy-eight, with side chambers and galleries. Park (200)[29] makes the interesting observation that Mandingo gold washing is women's work because it resembles the winnowing of grain.

We find hints of only two advanced techniques for gold collecting. Writing in the twelfth century of the gold of Sofala in southeast Africa, Idrisi (86)[30] tells us by the way that in West Africa the natives used mercury to dissolve the small particles of gold out of the dross, and that they then distilled this amalgam over a charcoal fire till only the pure gold remained. Three facts stand in our way of accepting this as an indigenous practice among the natives of the Western Sudan. First, no other writers mention it for this area. Secondly, the translation of Idrisi's account leaves uncertain his meaning of the term West Africa; he might have meant Morocco and Algeria (el Mughrab). Thirdly, this process had been known to Europeans and Arabs for a very long time, as attested by Theophrastus (300 B.C.), Vitruvius (13 B.C.), Geber (an Arab of the eighth century), and Birniguccio (an Italian of the sixteenth) (226).[31] Against these objections we may point out that mercury comprised part of the gift sent by the Sultan of Bornu to the Egyptian Sultan Ez Zahir Barquq at the end of the fourteenth century (194);[32] that it was worn as a charm against lice in the same century by the salt miners of Teghaza, in the western Sahara, who had extensive trade with the Sudan for gold (17);[33] and that anyone possessing gold and mercury in any quantities would probably observe the effect which they have on each other.

Park, at the end of the eighteenth century (200),[34] observed at Kamalia on the Upper Senegal a process to which I have been unable to find any other reference either in medieval or modern ethnographic accounts. He says that "most of the African blacksmiths are acquainted also with the method of smelting gold, in which process they use an alkaline salt obtained from a ley of burnt corn stalks evaporated to dryness." In the modern Plattner process, salt is added to the furnace to convert any lime, magnesia, or lead which may be present into their corresponding chlorides, and we can only guess that some such purpose is served in the West African case.

The Baoulé, says Himmelheber (119), usually melt down their gold dust into irregular lumps, often very impure, and keep these hidden in large pots buried in the ground. In Park's time (200),[35] the Mandingo kept most of their gold dust in quills stopped with cotton.

Unfortunately I have found no description of the West African manufacture of gold leaf, or of its application, specimens of which have been displayed by Himmelheber and others, and which Dapper (63)[36] may have had in mind when he mentioned the deceptive gold plating of copper and silver by which the natives of West Africa deceived European merchants.

Himmelheber informs me (119) that the Baoulé have no final treatment of gold to change its surface. We shall mention such treatment, as well as other methods of gold working, in the chapter on Casting.

Central Africa

In the great area drained by the Congo, we find gold in only two places: Angola and the Katanga. We have seen that the natives of the Western Sudan were only too ready to exchange their gold for salt, brass, and iron. The same low evaluation of the soft and useless metal characterizes the natives further south. Battell (16)[37] wrote of Angola in the seventeenth century: "These Gagas told us of a river that is to the southward of the Bay of Vaccas, that hath great store of gold; and that they gathered up great store of grains of gold upon the sand, which the fresh water driveth downe in the time of raine. We found some of this gold in the handles of their hatchets, which they use to engrave with copper, and they call it copper also, and do not esteeme it." Though the Negroes of the Katanga were finding gold nuggets in Cameron's day (46),[38] they did not value the metal as much as copper, preferring "the red copper to the white." Foreign trade in gold, just as that in ivory, appears to have been the chief stimulus to its output. In

28. 194: p. 81.
29. 200: p. 302.
30. 86: pp. 66-67.
31. 226: p. 90.
32. 194: p. 41 (Appendix).
33. 17: Vol. 4, pp. 377-79.
34. 200: p. 285.
35. 200: p. 303.
36. 63: p. 301.
37. 16: p. 383.
38. 46: pp. 475-76.

Arab slaving days in the nineteenth century, gold from Katanga was sent to the Sultan of Zanzibar (219).

East Africa

We shall have to exclude the Horn of Africa from consideration, since, as among the Galla (202),[39] gold and silver working was here learned from the Arabs, and belongs to an ancient culture which spanned the Red Sea. Only the dim record of Cosmas' Christian Topography (60)[40] carries us back to a time when the more enlightened people of this region were obtaining gold by silent trade from their savage neighbors, who seem to have valued it as little as did Negroes elsewhere.

But south of Lake Victoria we find more modern references to the precious metal. Pigafetta (209)[41] in the sixteenth century reported mines of gold and silver in Mohenemugi — probably the Nyamwezi country — and an export of gold for silk; and Dapper (63),[42] who quotes him, says that gold as well as copper was traded out of the port of Malindi to the Indians of Cambaye. Some of this gold may possibly have come through from the Katanga. Ahmed Razi, a Persian of the seventeenth or eighteenth century, says in his Haft-Iqlim that though East Africa have abundant gold, the natives prefer ornaments of iron, believing that iron protects the wearer from demons (125).

The Manyanja and Yao (301) obtained gold for the Portuguese, but probably worked very little for themselves. Werner (301)[43] says that these tribes know of gold only through dealings with the Portuguese, and have no word for it except ndalama, which is derived from the Arabic dirhem and means money, but when qualified by "white" or "red" means silver or gold respectively. Fülleborn (97)[44] claims that the Portuguese taught gold casting to the natives on the Lower Shire.

South Africa

South Africa west of the Transvaal seems to have lacked gold completely. Vasco de Gama reported that the natives at the Cape of Good Hope — Strandloopers? — showed no interest in the gold which he offered them. In view of their primitive and practical attitudes, this was to be expected, and one only wonders how sincere was his offer.

But if he had tried the Negroes on the east coast of South Africa he would certainly have received a different answer. The Transvaal, Southern Rhodesia, and Portuguese East form the only Negro area which seems to have vied with the Western Sudan in native gold production.

West of Tete, in the sixteenth century, flourished the fabled empire of Monomotapa, which, with the Manica district to the west, was both the goal and the disappointment of Portuguese greed. "From the shoares and coast that lyeth betweene the two foresaid Rivers of Magnice and Cuama," says Pigafetta (209),[45] "within the Land spreadeth the Empire of Monomotapa, where there is a very great store of Mines of Gold, which is carried from thence into all the Regions thereabouts, and into Sofala, and into the other parts of Africa. And some there be that will say, that Solomons Gold, which he had for the Temple of Jerusalem, was brought by Sea out of these Countries: For in the Countries of Monomotapa, there do remaine to this day many ancient buildings of great worke, and singular architecture, of Stone, of Lime, and of Timber, the like whereof are not to be seene in all the Provinces adjoyning." In 1569 an expedition left Lisbon to conquer the gold sources of Manica and Monomotapa. The Portuguese traded for gold between 1505 and 1760, but they found the output too slow for their ambitions — perhaps less than 1000 ounces a year (284) — and finally took to slaving to salvage their venture.

We can follow the gold of South Africa even further back into time. Idrisi (86)[46] in the twelfth century says that gold nuggets to the weight of one or two mithqals were found abundantly in the country of Sofala, where they were melted together over cattle-dung fires — presumably for exportation, since the natives valued gold less than copper.

These early references can undoubtedly be linked to the ancient gold mines which are so numerous north and south of the Limpopo. Extensive underground workings for gold have been found in the Transvaal; notably at Pilgrim's Rest in North Middleburg district (284,286) and on the farms Elandsfontein No. 167 north of Pilgrim's Rest(284), Wagondreft No. 765 in the Zoutpansberg District (284), Honingkloof No. 112 in Mapoch's Gronden (284), and as far south as Weltevreden No. 215 near Waterval Onder (284). On Honingkloof, where apparently between two and three thousand tons of gold-bearing quartz had been removed, the quartz reef outcrop had been taken out in one continuous trench in places fifty feet deep (284). On Weltevreden the old miners had dug trenches along a quartz lode (284), and in the Lydenburg District they mined complex ores of gold and red oxide (286).

Southern Rhodesia contains nearly a thousand old workings for gold, most of them from ten to twenty feet deep, the deepest one hundred and fifty. The average dimensions of the veins exposed in these are two hun-

39. 202: pp. 236-37.
40. 60: pp. 51-53.
41. 209: p. 514.
42. 63: p. 401.
43. 301: p. 8.
44. 97: p. 174.
45. 209: p. 507.
46. 86: p. 66.

dred feet long, fifty feet deep, three feet in width. About two and a half million tons of ore had apparently been mined. In some workings the exposure of ore still rich in gold suggests sudden abandonment (220).[47] Rickard believes that the female skeletons found in the old mines indicate that the Negroes themselves, rather than Europeans, directed the enterprise. He notes that a sixpenny piece of Queen Elizabeth, dated 1572, was found forty feet down in a stope at the Quagga mine (220).[48] No one has yet demonstrated, however, that these mines were contemporaneous with those for tin and copper in the same general area, which we shall discuss in a later chapter.

Gold seems not to have been an important metal for the Southeastern Bantu, at least within recent times. When the Portuguese first appeared, only alluvial mining survived (247); all lode gold mining had apparently stopped and they had to revive it (248). Baumann (19) states that the Ma-Karanga, who, he says, have occupied the hinterland of Sofala for more than 1,000 years, had no mining except panning for gold.

Nevertheless, there is some chance that the gold mines may have often been a purely native enterprise. At Gwanda, in Rhodesia, a skeleton of the local Negro type was found buried in an ancient gold mine (8). In the Limpopo Valley of the Zoutpansberg District, a grave on farm Griefswald No. 16 yielded some gold ornaments (203). This gold had been worked very thin, and included some ornamental tacks like those found in ancient graves and ruins in Rhodesia. In the same grave were found beads similar to those treasured as heirlooms by the modern BaVenda, and supposed by Stayt to indicate relationship with the builders of Zimbabwe (255).[49] Tradition has it that this is the grave of the last chief of the BaHaole, a BaKwena (Bechuana) group; and that this group mined and worked gold till the Matabele dispersed them (203). In 1865 a European exploring fifty "mijlen" from the coast in Natal found a chief wearing a metal armlet which was so heavy he thought it was gold, and the chief would not part with it for the neck-ring offered in exchange (33).

Schofield describes gold mining as practised by the Southeastern Bantu as late as 1891 (235). Each group of families under their chief camped separately at the selected site, where they opened a series of very narrow shafts. The miners stood on steps in the wall of the shaft and dug out the paydirt in wooden bowls. They crushed the dirt and rock to a fine powder, and washed this away in the river, leaving the gold dust on the bottom of the bowl.

It was a big leap from the fabled gold fields of the Niger and the Senegal to the mines of Southern Rhodesia and the Transvaal, but we shall have to make the same leap several times in the course of our review: for the earliest records of iron, for bronze, for special kinds of casting; and I believe that the conjunction of these diverse crafts and metals is not without significance.

SILVER

Silver was probably never smelted, and very rarely worked, in the indigenous Negro cultures, and early references to this metal seem to indicate no more than its discovery and exploitation by foreign pioneers. Such is Battell's note (16)[50] on the "infinite store of silver" in the hills of Cabambe in Angola, which local Negroes lustily defended — not, presumably, because they had worked these mines themselves, but because they resented the industrial intrusion. Dapper (63)[51] in the seventeenth century refers to the silver export of the "Monoemugi" (Nyamwezi?) country of East Africa, and to the silver on the Senegal, but only in conjunction with the gold sources in the same areas.

Cameron (46),[52] however, in the early seventies, bought from a native in Urua, north of the Katanga, a silver bracelet which he says was made in this district. In modern West Africa the most advanced use of the metal is the manufacture of silver wire by the Hausa (182),[53] which will be described in the section on wire-drawing; but other groups in the Western Sudan, such as the Fula (31) and the people of Fouta (84), make silver jewelry.

47. 220: Vol. 1, pp. 244-45.
48. 220: Vol. 1, pp. 253-54.
49. 255: Vol. 1, p. 35.
50. 16: p. 437.
51. 63: pp. 393, 236.
52. 46: p. 476.
53. 182: Vol. 1, pp. 156-57.

II. NEGRO IRON-WORKING IN ANTIQUITY

ARCHAEOLOGICAL RECORD

Within the bend of the Niger lies the only large area where iron remains have been found associated with stone-using cultures. Detritus heaps examined by Desplagnes (77, 78) on the Central Nigerian Plateau — especially at Sumpi, Gourao, and Koulikoro — are exemplified by the Koulikoro site, which yields, in addition to iron slag, incised and cord-impressed pottery, stone hammers, pestles, and scrapers, and stone mills and mortars which have long been obsolete here. Sites which the natives of Koulikoro call "old workshops of smiths" show the same Neolithic inventory. Tumuli between Timbuktu and Lake Debo, and between the Faguibine and Lakes Nyangay and Do, have a hard external covering including potsherds, rocks, and iron slag, with remains of smelting furnaces on top; and at Sumpi, northeast of the lake, a large iron-bearing tumulus stands near a Neolithic camp site, the contents of which resemble closely those of the fishing site of Debo, on the Gourao massif, with its iron slag, iron hooks, and coarse pottery. The large Nigerian tumuli, with copper and iron, also contain stone implements.

But another class of sites in the same area apparently lack most of these Neolithic associations and make a good show of copper. Burials in dolmens near the village of Hombori-Maigu yield copper ornaments, iron arrowpoints, and knives (78).[1] A tumulus near El Oualedji (78) — on the surface of which have been found iron horse-trappings, iron weapons, and a few stone axes — encloses a funerary chamber containing bracelets, rings, and ornaments of copper, and trade glass beads, as well as many iron weapons. The copper work is very fine, some having "filigree" decorations. At Badiena and Dieguinebougou, near the same town, the Niger has cut its way into some old mounds, revealing objects of iron and copper, glass beads, and pottery superior to the modern wares of the neighborhood. The hard revetment layers covering tumuli on the edge of the sink of Goundam are composed largely of iron slag, potsherds, and bones, while skeletons with ornaments of iron and copper lie buried within. Excavations to the north and east show the same styles of interment, with the skeletons accompanied by ornaments of copper and bronze and surrounded by heavily oxidized pieces of iron. Mounds of this type, and "probably containing the same kinds of things," occur also in the east, near the marshes of Amenaka, and on the banks of the Niger as far down as the Boussa rapids. They are distributed as far south as the Baoulé and Kong districts in the hinterland of the Ivory Coast; and as far west as Sikasso and the banks of the Faleme and Senegal Rivers. Similar sites on the Central Nigerian Plateau are at Aribinda, Boudiogara, and Kane-Kombole.

I cannot find in Desplagne's writings any clear statement of how many early metal-bearing cultures he distinguishes within the bend of the Niger. If we line up the various sites which he discusses, they seem to fall into two classes: first, those which show an abundance of stone implements and no metal but iron; secondly, those which yield copper and bronze as well as iron, lack remains of a Neolithic character, and suggest the rich culture of Ghana which was so vividly described by El Bekri (25)[2] in the eleventh century.

Desplagnes persistently declares that metal working was introduced to this region by invaders who bult the tumuli and who distinguished themselves by their brick and stone architecture and their fine weaving and pottery, as well as by their metallurgy (78).[3] Various types of burials around the iron workshops suggest foreigners. The area, however, has been open to cultural and racial movements from so many directions that to explain its advance into civilization by any single invasion seems the height of folly. I cannot but believe that we have here at least two levels of metal-working: the earlier representing the transition from Neolithic to Iron; the later, a glamorous medieval culture with iron, copper, bronze, and gold, partly of non-Negro derivation. This sequence will seem more natural when I have shown, in a later chapter, the absence of copper ores in Negro West Africa, the abundance of iron, and the highly sophisticated technique by which gold and copper were fashioned.

Northern Nigeria may be considered as the eastern end of this region. From Jos, in Bauchi Province, Meek reports an iron hoe found eighteen feet below the bed of the Delimi River "at the same horizon, or even lower, than that in which stone implements have been found." The same author mentions iron bangles, some of which were cemented together, at a depth of fourteen feet in the tin-bearing wash of the Forum River (182).[4]

1. 78: pp. 31, 28, 55, 59, 29, 30, 368-69.
2. 25: pp. 329-31.
3. 78: pp. 15, 16.
4. 182: Vol. 1, pp. 53-54.

The presence of stone implements equates the former group of finds with the transitional Neolithic-Iron period further west.

As yet I have found only one other area where iron makes any serious claim to antiquity. This is the far south.

Though the modern smiths of South Africa show only modest attainments, their forerunners produced iron at a remote period by a process virtually unknown elsewhere in the Negro area. Mumbwa Cavern, where Dart and del Grande (69) have found this evidence of early smelting, lies within the bend of the Kafue River, in the territory of the modern Balla.

Though rather small in its present dimensions, the cavern contains about twenty-two feet of stratified fill. The bottom stratum, about five feet thick, bears Early Paleolithic implements. Over this come seven feet of sterile clay. The next layer, a thin and undulating one, includes fractured quartz, quartzites, sandstones, and ironstones, and yields implements of the South African Mousterian type. At the highest point of this layer we find the remains of the smelting furnace, an oval foundation of charred limestone blocks from the ceiling of the cave. The furnace itself, of which only the foundation stones remain in position, was probably of beehive shape, built of limestone blocks packed with clay. The limestone of the foundation has been burnt to a red, friable condition, and the cavern roof to the west above the furnace is charred and reddish. Apparently the furnace was demolished after every smelting, and the discarded walls were dumped to the west of the cavern where the metal was probably cooled, so that the prevailing east wind of the dry season would carry the bad fumes away from the workers. Ash, however, was piled to the east. Since no tuyeres or other bellows accessories were discovered here, the site may have originally been selected to give the best possible natural draught. Over the furnace lies a two or three foot layer of solidified furnace ash; then a stratum of somewhat greater thickness containing Neolithic implements and pottery. The uppermost layer of all yields several iron arrowheads. Stone implements throughout these strata, from the Mousterian level of the furnace floor to the surface of the deposits, show, uniformly mixed, the essential features of the Glen Gray, Still Bay, Smithfield, and Wilton cultures, with potsherds and doughnut-shaped digging-stick weights scattered here and there. The stratification seems to indicate: first, a genial and probably dry period, when crude Paleolithic implements were left in the cave; next, a rainy period, when a thick layer of clay was washed into it and nobody lived there; then a Mousterian occupation; then a period when the furnace was built and implements of Late Paleolithic and Neolithic types were deposited; finally, a phase of relative drought, when the ash and furnace detritus were covered to a depth of two or three feet with wind-blown sand, in which Bushmen and other peoples occasionally lost their things.

Dart and del Grande place the sterile clays in the Buhl period, and synchronize the upper ten feet of cave strata with the formation of the Kalahari Desert after the Buhl rains. Within this era of desiccation, which culminates with the wind-blown sand at the top of the deposits, they date the Mousterian level at a minimum of 4000 B.C.; the furnace deposit 2000 years later at the beginning of the South African Neolithic. They go so far as to suggest that these Late Stone Age cultures "owe their birth, amidst a Paleolithic environment, to the earliest metallurgists in South Africa."

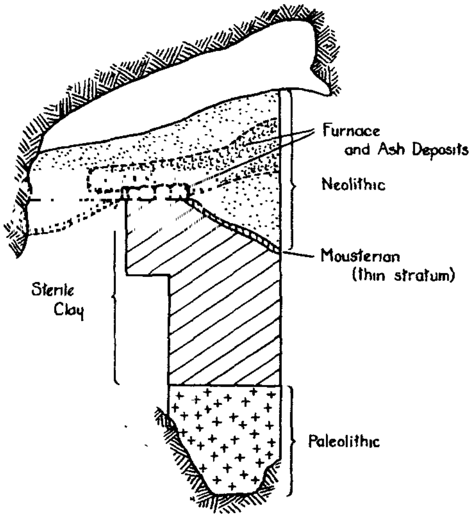


Fig. 1. Cross-section of the Mumbwa Cavern, to show stratification (adapted from 69, p. 386).

In view of the fact that no very ancient remains of iron have heretofore been found in Negro lands, Dart and del Grande's sensational date for the Mumbwa furnace stands open to attack. The authors seem to have been thinking upside down, being so impressed with the antiquity of the strata below the furnace level that they too readily gave a great age to the furnace itself.

It will be noticed in the sectional drawing that the furnace ash, instead of resting directly on the Mousterian floor as it would have done if the smelters had been occupying this floor, has been deposited on a higher level, separated from the Mousterian by an Upper Paleolithic and Neolithic filling which in places reaches a thickness of four or five feet. The only place where the ash approximates the Mousterian level is at the furnace itself. We should assume, it seems to me, that the smelters set their foundation stones somewhat below the surface. The spot they selected happens to coincide with the summit of the Mousterian deposit, perhaps because of the central position in the cavern, or because the bit of Mousterian floor here exposed offered a more solid base than

did the surrounding fill.

Above the furnace we have two or three feet of ash, enclosed in wind-blown sand which contains pottery, Bushman digging-stick weights, chipped stone implements of Smithfield and Wilton types, polished celts of iron ore, and pieces of limestone fallen from the ceiling. Four or five feet of such a deposit hardly convinces us of as many thousand years of antiquity.

The only fact of great interest which emerges from a study of the stratification is that Neolithic peoples, using the above assortment of goods, certainly occupied the cave after iron had been smelted there. In view of the known overlapping of cultures and races in South Africa, this apparent anachronism need not surprise. It is certainly not as puzzling as the situation at Ezulweni, in Swaziland (69), where iron bangles or rings are said to have been found in "close association" with stone fist axes!

Along the western approach to the cavern lies a mass of slag refuse about a hundred feet in length, which has solidified into blocks as hard as rock. At the cavern's front, and immediately outside, we find the charred marks of numerous other furnaces. All this shows great smelting activity and the production of a vast quantity of iron, but, as we know from other African sites, no more than could have been done by Negroes within a few generations.

But even if we cannot follow Dart and del Grande in their bold estimates of years, we still must agree that the Mumbwa furnace deposit is very old, perhaps the oldest evidence of iron-working yet found in Negro Africa, and that it shows a type of metallurgy which differs essentially from that of the modern Bantu.

None of the iron smelted at Mumbwa has been recovered, but we know something of its qualities from the evidence given by the ore, the slag, and the fluxing materials found on the site. The ore seems to have contained about 2.2% of silica and 97.2% of fine crystallized haematite, which, in turn, contained 68% of iron. Modern Negroes, in producing wrought iron, simply smelt the ore in contact with the charcoal fuel, allow the iron in a pasty condition to take on a little carbon, and beat the pieces of slag out of it after extraction from the furnace. The Mumbwa smelters, on the other hand, employed bone and quartz as fluxes. We not only find pieces of these materials at the site, but observe in the slag a high proportion of calcium silicate derived from the flux, which caused the slag to fall into ashes on cooling and to set like concrete when it became wet. In the smelting process, a flux neutralizes the impurities in the ore, thus making the slag more liquid and helping it to protect the droplets of iron against oxidation as they descend through the furnace; while phosphorus derived from the bone flux — apparently used by the Mumbwa smelters — would lower the melting point of the iron, thus making it easier to cast. All modern iron and steels contain some phosphorus, probably as iron phosphide in solution; but this should never exceed 0.04-0.06% in good commercial steel, or 0.03% in steels for fine tools. Steels containing more than 0.04-0.06% of phosphorus may be "cold short" — that is, very brittle when cold.

The Mumbwa iron, therefore, must have been quite brittle, since it was liquified and absorbed much phosphorus. Dart and del Grande believe that it was no good for weapons or rough work, and that it was cast into ornaments rather than beaten into shape. They infer that the natives treated it as a rare metal, from its absence in the furnace stratum, and from the presence of another ferrous luxury, specularite, which is relatively useless as a source of metallic iron, but which has been extensively mined and traded by the Southern Bantu as a cosmetic. I can see no reason, however, why the excess phosphorus should not have been removed by subsequent reheating and hammering, just as the excess carbon is reduced by the modern Southeastern Bantu; from whom, be it noted, we shall cite several references to iron being roughly cast before it is forged.

In the surface layer in the cave were found five arrow- or javelin-points of malleable iron, wholly unlike the metal that was produced here. They seem to be associated with decorated potsherds and stone implements of Wilton types. They may have been traded to the Bushmen or left here by Negroes, but their forms are distinctive. Unlike the iron points of the local BaIla, they have no midribs, and one has a spirally twisted shaft. The lack of a midrib suggests a connection with the steel or wrought-iron arrowheads from an ancient iron-working at Messina in the northern Transvaal (69), and with the small iron spearheads found in Hill Wash Stratum 2 in the Maund Ruins at Zimbabwe (50),[5] three hundred miles to the southeast of Mumbwa.

The iron and iron slag found in the earliest deposits at Zimbabwe give us a minimum dating of about the eighth century A.D. for the beginning of iron working in Southeast Africa (50). At that time, however, the local "Iron Age" was already well advanced, for though a few Neolithic sites have been found near Zimbabwe, nothing indicates that the Zimbabwe people ever used more stone tools and weapons than do the modern Negroes of the region, who use almost none. Iron objects continue in abundance throughout Zimbabwe's whole archaeological history, their forms apparently remaining the same (50),[6] though they have rarely been pre-

5. 50: pp. 26, 188.

6. 50: pp. 184, 200-202.

served from corrosion. None of them show any indication of the Mumbwa type of smelting. Stanley (50) and Desch (50) describe Zimbabwe iron as follows:

"Ferrous specimens vary from practically carbonless iron to medium carbon steel and have apparently been made by forging down semi-fused, or perhaps, occasionally fused, lumps of metal together. All show entangled slag, though, in general, less than in modern wrought iron, but the general lack of homogeneity shows that they were not made from single lumps of previously fused metal. ... This structure and the irregular distribution of carbon is consistent with the making of iron by the direct process, but affords no evidence of age. From about 1500 B.C. down to the direct smelting of iron by negroes at the present day, the process has been essentially the same, and I know of no way of distinguishing by means of the microscope between early and late specimens."

Only three other alleged finds of early African iron deserve mention. Wells (300) has reported the remains of old furnaces in Cathkin Park, Southern Rhodesia, but they are probably recent. A site thirty miles southeast of Francistown, in the same colony (81), is somewhat more significant in the Mumbwa connection, since quartz found with the iron slag suggests the use of a flux. The metal ring, "almost certainly iron," which Leakey (155) found in doubtful association with a presumably Neolithic burial in the Eburru district of Kenya Colony, and which he lost before it could be studied, suggests the early use of cast iron there, though the Nilotic tribes not far away are said to cast rings of iron by the cire perdue process. Leakey suggests that this ring was traded into the Neolithic community from a foreign source, for he found agate and faience trade beads in burials of the Gumban B culture from about the same period, approximately 850 B.C. Since no stone tools were found with it, we can hardly allow any dating whatever.

We have only the merest suggestion that ancient Egypt may have obtained iron from Negro sources. The word used for iron in the inscriptions at Abu Simbel, on the southern frontier in the thirteenth century B.C., is bia-en-tabol, "foreign marvel" or "foreign iron;" whereas the Pyramid texts of the Sixth Dynasty call iron bia-en-pet, "marvel from heaven." The latter term might indicate meteoric iron. It is not till the Roman period, as shown in inscriptions at Denderah bearing cartouches of Nero, that iron was called bia-nu-ta, "marvel of earth" (220).[7] The Abu Simbel term thus suggests a southern importation, but little weight can be given this evidence until Egyptologists have assembled all their data on metals.

HISTORICAL RECORD

In the absence of good archaeology, we must turn to historical record. For the Western Sudan, this offers very little aid. The failure of contemporary Arab authors to mention iron as an import to the Sudan, though they frequently mention copper as such, confirms the suggestion taken from archaeology that the Negroes were smelting enough for themselves. El Bekri in the eleventh century (25),[8] who, though he did not go there himself, left a very good account of the country from hearsay, says that the natives of Silla on the Niger hunt hippopotamus with iron-pointed harpoons. Maqrizi, however, four centuries later (194),[9] gives us our only contemporary note on the Negro Neolithic. He claims that the Tajo, a tribe of Zarawa which he locates ten days' march east of the mountains in the central Sudan, in a region through which the "Nile" passes on its way to Egypt, work in stone. These were probably the vaguely defined Zaghawa, near Kanem and Wadai (102). But for lack of better evidence, these rumors do not merit further consideration.

For East Africa, historical data are much more suggestive. Two passages in the Periplus of the Erythraean Sea (6)[10] suggest that in the first century of our era East Africa was importing its iron. One alludes to iron from Ariaca, in India, being traded with other Indian goods into Abyssinia; the other, to the importation into Rhapta (probably Kilwa, perhaps Pemba or Zanzibar) of lances which were made at Muza (Mocha) in Arabia especially for this trade. Iron seems to have been moving in the same direction in the sixth century, for the Egyptian monk and topographer Cosmas Indicopleustes (60)[11] says that the people of Axum in Abyssinia purveyed beef, salt, and iron to the coastdwellers of Zenj — East Africa — in exchange for gold nuggets by silent trade.

When we come to the Middle Ages we find a curious reversal. Medieval commerce between India and East Africa is attested both by archaeological data — such as the melange of Chinese porcelain, Persian glazes, and Indian trade beads at Zimbabwe (50) — and by numerous passages in authors of the time. Biruni (90),[12] writing his History of India in the early years of the eleventh century, informs us that Somanat, the port of Kathiawar, had become especially important as a harbor for those who fared by sea between Sofala, in the country of Zenj, and China. But the iron now seems to be flowing eastward instead of westward.

Idrisi (86),[13] in the second half of the twelfth century, says that the chief products of Zenj are iron and "tiger" skins. He also reports that the people of Melinde and

7. 220: Vol. 1, p. 148.
8. 25: p. 325.
9. 194: p. 87.
10. 6: pp. 24, 28.
11. 60: pp. 51-53.
12. 90: p. 552.
13. 86: p. 58.

Manisa, on the same coast, mine and export iron. In describing Sofala he gives some very pertinent data. He says that the people of the two small coastal towns of Jentama and Dendema are miserably poor and live entirely by their iron, of which there are a great number of mines in the mountains behind them. "The people of the islands of Zanej [Java] and of the other neighboring isles come here to seek iron to take to the continent and islands of India, where they sell it for a good price, for it is an object of great trade and consumption in India; and although it exists in the islands and mines of that country, it does not equal the iron of Sofala, either in abundance or goodness or malleability. The Indians excel in the art of working it, in that of preparing the mixture of substances by which,in fusion, the soft iron called 'iron of India' is obtained." The same author refers to fine swords made from local iron at Qalgur in Abyssinia (178).[14]

The East African iron trade still continued in the thirteenth century, for Ibn Sa'id describes a great iron mine on Mount Kharani, east of Malindi, which produced considerable metal for export as well as for local consumption (91). Ibn el Wardi,at the beginning of the fourteenth century (90),informs us that "the Sofala territory contains mines of iron which the natives exploit, and the product of which they sell to the merchants of India, who pay dear for it because it is harder and of a better temper than that of their own country." According to Maqrizi, who wrote about a century later, iron was then exported by the natives of Southern Nubia (261). When we consider that a thousand miles of coast separate Malindi from Sofala, and that both these towns were exporting iron in the thirteenth century, we can judge the breadth of territory which must have been affected by foreign trade in metals.

Going back a few centuries earlier, we find another hint of this wide commerce. The Chinese port of Khanfu (Canton) was destroyed by certain disturbances about 878 A.D. "From that time," says Kramers (146) "regular Arab navigation did not extend farther than a town which the Arabic authors call Kala, famed especially for its tin mines,the position of which must be sought on the western coast of Malacca. Kala was politically dependent on the ruler of Zabaj, which name is the early Arabic rendering of the name Java."

The earliest reference to Kalah which I have yet found is that by Ibn Rosteh at the beginning of the tenth century, who names it as a port on the route between China, Java, and East Africa (91).[15] About fifteen years later, Abu Zaid mentions Kalah as a center of commerce in aloes, camphor, sandal, ivory, ebony, and "kala'i lead" (91). This metal was so called because it was said to have been found in the fortress (kala'a) of Kalah. It was undoubtedly tin. One may here suspect a confusion between "Kala" and "Kalah," since Ibn Sa'id in the middle of the thirteenth century attributes to Kalah an excellent malleable metal called "kalahi," as well as stating that "kala'i lead" is found on little islands off Java (91). Ibn Serapion, about 950 A.D., associates Kalah with Sofala and Java as a source of camphor (91). From then on through the eighteenth century, Arab authors often mention the place in connection with tin and other products. About 1000 A.D., Ibrahim bin Wasif-Sah describes it as a great island midway between China and Arabia, and inhabited by Indians (91). Two centuries later, Yakut tells us that Kalah has a mine of a kind of metal which exists nowhere in the world except in its fortress, where sabres are forged (91). Kazwini, his contemporary, states that the sabres called kala'iyya are forged in Kalah, a fortified Indian town subject to the king of China, and that they are the best in the world (91). At about the same time, Ibn al Baytar distinguishes two kinds of "lead" — "black lead" (usrub and abar), and "kala'i lead" which is better (91).[16]

The foregoing references deal with three distinct metals: lead; tin, which the Arabs apparently confused with lead; and iron or steel. The last is not specifically mentioned; but I do not believe for a moment that tin swords could be described as "the best in the world," or that a tin-copper alloy would have failed to receive the designation of nahas, the Arabic blanket term for copper, brass, and bronze. The swords forged at Kalah were probably made, at least in part, from East African iron, which Idrisi and Ibn al Wardi say was exported to India in great quantities. Ibn Rosteh strengthens this supposition by placing Kalah on the trade route from East Africa to China.

Thus it is very tempting to place the beginning of iron-working in East Africa at some time between the sixth and twelfth centuries and to ascribe it to the stimulus of trade with India, Arabia, and Ethiopia. This would allow a century or more for the growth of iron-working at Zimbabwe, and might even cover the Mumbwa case to the satisfaction of everyone except Dart and del Grande.

NATIVE TRADITIONAL RECORD

Though we can hardly expect folk memory to have preserved any word of the earlier history of metals, it may give us some hints as to later diffusion.

Native traditions of the origin of metal working, just as those of the other crafts, should hardly be taken at face value.

14. 178: p. cccxxiii.
15. 91: pp. 69, 83, 324, 112.
16. 91: pp. 152, 313-14, 274.

When a number of informants in a single tribe or area say that their people learned metallurgy from certain of their neighbors within the last few generations, they are probably right. At least we should be more inclined to believe them than if they asserted that they had known the art since their creation, or that surrounding peoples had stolen the secret from them. But all traditions may conceivably arise and diffuse as elements of folklore on their account, and be modified to fit the local fashion in culture heroes, trade-guild histories, and other fictional patterns. They have historical worth only after allowance has been made for the general trends of folklore and in so far as they may be correlated with other types of data on the subject. The examples which I have collected are too scant and scattered, and the folklore patterns too little studied, to allow this correlation. Let us review the following notes with these words of caution in mind.

In West Africa traditions of the origin of metallurgy seem very rare. The Baya (177) on the Upper Kadei River say that they have not always worked iron; old men in 1915 telling of a time eighty years before when shoulder blades were used as hoes; the only weapon commonly used was the bow and arrow. At that time a slave was the price of a single spear-head. They claim that the people who introduced iron-working came from Gaza; Poupon suggests that these were probably Fula. Natives in the Anecho district of Togo say that they learned smithing from the Portuguese; but those in the Togo hinterland claim to have learned it from slaves from the interior. The northern derivations are suggestive, but we have not enough cases to argue this point with confidence. Indeed, one case indicates diffusion from the south and east. Diedrich Westermann tells me that the Ewe believe that they did no iron-working before they came into their present country, when they first learned it from the local natives; and that their iron is still worked by these original inhabitants, who live among them and speak a semi-Bantu language entirely different from Ewe.

Traditions of an intertribal derivation of metal working occur sporadically throughout the Congo. Here the folklore points mainly northward and eastward. Johnston (134)[17] says that the Lunda and Kioko trace their metallurgy to Lubaland in the east, but that all other tribes, from Damaraland on the southwest to the BaHuana and BaMbala on the northeast, derive it from the north. The BaYaka, who do not smelt iron for themselves (283), seem to have learned smithing from the north, perhaps from the BaTeke (134) or BaMbala (283); while the BaYanzi brought it to the Lower Kasai tribes, probably from the BaKuba (Bushongo) and BaSongo. Johnston (134), whose pro-Hamitic bias should be discounted, says: "The BaKuba strain has given a ruling class to the BaLolo in the central basin of the Congo. BaLolo is said to mean 'men of iron', 'iron workers', and indeed nearly all these aristocracies founded by Hima adventurers have been associated in legend with the introduction of metal into a land still in the stone age." Torday and Joyce claim (283) that some of the tribes south and west of the Kasai were ignorant of metallurgy until relatively recent times, and have traditions of learning it from their neighbors; that it apparently diffused westward from the Kwango, with the BaSongo, and BaHuana as possible "originators." The northern BaHuana, who do not smelt iron for themselves, say that they learned iron-working from the southern BaHuana (BaHoni). The northern BaMbala, who have abundant iron mines, claim to have received the art from the BaHuana, their neighbors on the northeast; while the southern BaMbala say that they got it from the BaSongo. The BaBunda trace their metallurgy to a people on the right bank of the Kwilu, whom Torday and Joyce identify as BaSongo. These authors, however, make the significant comment that no stone implements are found in the country of the BaMbala or of their neighbors.

The people of Uganda and Urundi agree in tracing their metallurgy to an area between these two regions; the BaRundi, to the Kissaka district north of them, from which the culture hero Kigwa introduced the craft in the reign of their first king; the Baganda, to Bunyoro (Kitara), a district rich in ore, where the Muganda prince Kimera learned the iron-working which he taught to the Bushbuck gens of Uganda on his return. Meyer (186) dates the introduction of iron-working into Urundi about 200 years ago; while an old native told Van der Burght (261) that he had seen wooden hoes and weapons still used when he was a boy. Roscoe believes, in spite of native tradition, that there were iron-workers in the southwest of Uganda even before Kintu's reign. The important deduction here is that Ruanda, Unyoro, and intermediate regions seem to have been a center from which iron-working spread both north and south.

Further east, the Masai attribute the craft to an immigrant who came long ago (185); and the Nandi have traditions of the time before they wrought their own iron, when they bought their axes and other iron goods from neighboring tribes, and when their spear-heads were very small and their digging tools of wood (124).[18] In those days the Nandi had only one blacksmith. He taught the trade to some Uasin Gishu Masai who, having lost their cattle among the Masai, settled among the Nandi and took up smithing. The Masai origin of the Nandi smiths calls to mind similar indications among the WaChagga (107).

Further south the WaNyamwezi relate (218)[19] that long ago they tilled the soil with wooden hoes, and that the people of

17. 134: Vol. 2, pp. 806, 517-18.

18. 124: pp. 36-38.

19. 218: p. 98.

Turu did so as late as 1910. In 1914, old men of the WanIramba said that most tools were of wood in their grandfathers' time. Turu and Iramba lie together on the eastern central borders of the Nyamwezi country. Their late knowledge of metallurgy thus seems to preclude a western diffusion into central Unyamwezi, and leaves the west or southwest as the direction from which the industry reached the Southern WaNyamwezi.

In the Lake Nyasa region, the Mwera assert that they formerly had no iron and used hoes of wood or shell, while the Yao say that they learned iron-working from the Mwera, having previously — even within the memory of some old individuals living in 1910 — cultivated with wooden hoes (261). The MaKonde claim to have derived iron-working from the coast natives, or from the recently arrived Yao and Makua.

The BaThonga in Portuguese East Africa tell of a pre-metal age, and of the primitive Honwana people of Nondwane, who, lacking iron, cooked elephants whole in order to tear them to pieces (137). Natal natives say (42)[20] that the Ntlozi (Aba-kwa-Ntlozi), living on the spit of land which separates Santa Lucia Bay from the sea, had no iron a few generations ago, and that they were attacked and robbed of their cattle by the Mbonambi from the mainland, who specialized in iron-working and the making of assegais. Though this tradition includes the supernatural theme of parting the waters to allow the invading host to cross the bay, it is probably semi-historical.

Let us now turn to the other side of the picture, to peoples who are definitely stated to have no tradition of the origin of iron-working, or who claim to have practised the art from the beginning. Though some of the Fang attribute the discovery of iron to the Pygmies in remote times (29), the Pangwe claim, as descendants of Mode-Sama, that they have always known it. They admit, however, that they are surpassed in metallurgy by other tribes who are descended from Ngomwenio (269). In the Congo, the Bushongo (BaKuba and others) relate that iron-working was revealed in a divine dream to Woko, their fourth chief in direct line from God, well before their migration southward; while the BaSonge say that it was taught to man by Efile Mokulu, the Creator.

In East Africa, Routledge (227)[21] tells us that his Kikuyu informants could not imagine a time when iron was not in use. Despite the belief of the BaGanda that they themselves derived iron-working from the west, the Tobur smiths of Uganda have no traditions of a foreign origin of their craft (257). These two statements suggest early iron-working north of the BaGanda and east of Lake Victoria, probably to be derived from the Horn of Africa.

The southern BaNyamwezi give iron-working a divine origin, claiming that it was taught to Zina, the younger brother of King Makalasinde, by Lindini, the tutelary god of the forests (218).[22] When we couple this with the tradition of the recency of iron working in Iramba and Turu, we may suspect that the craft reached these latter districts from the southwest. This conclusion is substantiated by Reche's explanation of the use of drum bellows in Iramba — trade with the southwest — whereas the WanIssansu, north of Turu and Iramba, have derived their bag bellows from the northeast (218).

In Northern Rhodesia, both the BaKaonde of the Kasempa District (184) and the BaTwa of Broken Hill District (170) say that Leza the Creator, instructed their earliest ancestors in metal working. The BaSuto, further south but of a northern origin, claim that their first ancestor was Noto (hammer), son of Morolong (smith); and, according to Junod (136), the BaSuto of Klein Letaba believe that they were created "holding in their hands the instruments of the forge." The BaRolong ("smiths"?) of Bechuanaland have iron (tsipe) as their totem, and are accordingly called Ba-Bena-Tsipe or Bena-tsipe, the "sons of the dancers of iron," or "the dancers of iron."

The foregoing traditions, dismembered and fictitious though they be, give us one or two helpful suggestions. These are: (1) that iron is relatively late in the cultures of the central East African grasslands; (2) that it entered the general Nyamwezi region both from the southwest and the northeast; (3) that it is likewise late in certain spots in tropical West Africa, notably in the old Ewe homeland and the interior of the Cameroons; (4) that the Congo area in its broader sense, as the scene of the most bewildering migrations and differences in cultural level, is characterized by the most varied metallurgical histories, iron-working being old among some Congo peoples, new among others, and transmitted in many different directions; (5) that iron-working came into the Congo generally from the north; and (6) that from the northeastern Congo area, rather than from the Nile or the Horn of Africa, came the iron-working industries north and west of Lake Victoria. One derives the general impression that the northern Congo and the central and western Sudan form a relatively old iron-working area; and the same may be suggested for parts of Northern Rhodesia.

20. 42: pp. 104-19.

21. 227: pp. 79ff.

22. 218: p. 98.

III. THE MODERN DISTRIBUTION OF IRON-WORKING AND MINING

NON-IRON-WORKING GROUPS

There are only three cultural groups in all of Negro Africa who know nothing of iron-working: the Pygmies of the Equatorial forests, the "culturally pure" Bushmen, and the people on the island of Fernando Po off Mt. Cameroon. I am not sure about all of the Pygmy tribes; at any rate, most of them dwell in close economic relation with local Negroes from whom they may receive iron objects. The Bushmen are — or were — generally more isolated, and the absence of metals is merely one of their numerous primitive traits.

The lack of metal-working among the Negroes of Fernando Po suggests two possibilities: either the inhabitants came to the island before iron was known on the adjacent mainland, or they lost it after their arrival. The first alternative would be far more interesting, but I fear that it cannot yet be demonstrated. All the available evidence points the other way. The Fernandians speak Bantu dialects, denoting a recent migration; their volcanic island seems to offer little or no available iron ore; and though their material culture is superficially inferior to that of the mainland tribes, it seems to be a degenerate offshoot of the latter, rather than a fully developed Neolithic. Their stone forms are extremely crude, and they haft their axes in the same way as do Negroes elsewhere. Moreover, they make a startling array of wooden bells, close copies of the metal bells of the mainland (270).[1]

From the Sahara to the Cape, all peoples except the three just mentioned either work iron for themselves or receive it in such profusion from their next door neighbors that it is still an essential part of their material life, second only to agriculture or cattle-raising. The few groups who do not work their own forges refuse to do so because of industrial snobbery or because they have specialised along other lines and find it easier to import their metal goods from tribes around them, not because they are still on a Neolithic level.

While copper is produced in only a few areas in Negro Africa, iron has a continental distribution. But in some regions iron-working is weakly developed. One of these, oddly enough is the Ivory Coast, where none of the tribes do their own smelting (266).[2] Those in the eastern part of this region — the Agni, and the people in the upper basin of the Camoë — used to import their iron through the Mande-Dyoula from the Bobo-Dioulasso district, but now buy it all from European traders (266). Likewise the Ashanti (38)[3] and the people of northern Liberia now do no iron mining or smelting. One might compile a long list of Negro tribes who get all their iron from others; but probably in every case we could explain this deficiency by a lack of good ores in their own districts, or specialization in mining and smelting among their friendly neighbors; and in none would it certainly imply an original ignorance of metallurgy. I therefore name only such non-smelting groups as I have gathered casually from my notes: Northern Liberia, Agni (266), Ashanti (38), Edo (275), BaNkutu (283),[4] BaKwese (283), BaYaka (283), Mayombe (196),[5] BaHuana (283), BaRundi (186),[6] Ruanda (62), Shilluk (121, 303),[7] Lango (82),[8] WanIssansu (218),[9] WaNyaturu (218), Safwa (145),[10] WaSandawe (75),[11] Early Koranna Hottentots (258).[12]

SPECIAL SOURCES OF IRON

Iron ore abounds in surface rocks and soils throughout most of Africa south of the Sahara. Though a complete list of the tribes mining it would include most Negro groups, and is hardly possible from the data at our disposal, we may profitably mention a few of the chief iron-mining centers and the kinds of ore obtained there. We usually find that a tribe has certain favorite sources, or that within a given area certain communities work the mines and specialize in smelting.

South Africa

Thus, though iron ore was plentiful in many parts of Natal, Gardiner (33)[13] says that the Zulu exploited it only in the mountains around the headwaters of the Amatikula River. The BaVenda in the highlands of the Transvaal mined and smelted iron not only for themselves but for the BaThonga and other groups in Portuguese East (137).[14] Livingstone (160) reported abundant iron ore in

1. 270: pp. 203-205.
2. 266: pp. 44-45.
3. 38: pp. 312-13.
4. 283: pp. 350, 145, 181.
5. 196: pp. 195 ff.
6. 186: pp. 83-85.
7. 121: pp. 320-21; 303: p. 105.
8. 82: pp. 86 ff.
9. 218: pp. 58-59.
10. 145: pp. 180-82.
11. 75: pp. 108-109.
12. 258: pp. 270, 276.
13. 33: Vol. 1, p. 305.
14. 137: Vol. 2, pp. 137-40.

the Saloisho Hills, mined by many of Shinte's BaLonda. The lower Zambezi has great quantities of specularite and rich black oxide. The latter occurs mainly as tears or rounded lumps, only slightly magnetic; and when present in river beds is conspicuous on the surface (160).[15] The BaSenga, famous iron workers, had especially fine sources, some ore showing veins of pure metal (160). The ore in the Lindi hinterland, magnetite, is mined and reduced only at certain places, such as Newala and on Mt. Ssengwa (97).[16]

At Kimbokwe near the Zambezi, Cameron in the early 'seventies (46)[17] found the Negroes dredging nodules of iron ore from the river beds at the end of the dry season, smelting them in furnaces of "peculiar shape, and exporting large quantities of iron to the Lovale. The same traveller found the WaVira sending iron objects and pottery to the markets of Urundi — an interesting association of goods, since we know that among the tribes north and west of Lake Victoria smiths' wives were often the potters.

East Africa

Cameron (46) found the northwestern part of Unyanyembe a great iron-smelting center, which exported hoes as far as the East Coast. He notes the abundance of hematite in Unyamwezi, Ubudjwa, and Uhuja, as well as at Munza in Urua; and the fine black specularite of the Manyema country, the produce of which was very highly valued.

Among the BaNyamwezi, the concentration of ore in a northerly and a southerly center leads to specialization of iron-working by the Longo in the north and the Sara in the south. Unyika is an especially rich iron-mining district (97)[18] and exports iron to the Safwa, who have no ores good enough to smelt. The Nandi find ore particularly abundant at Kaptilol in Emgwen, where many smiths live (124).[19] In the Uganda Protectorate, magnetite occurs at Budolo Hill in Masaba, at Negarive Hill in Bukedi, at Jinja in Busoga. The haematite used by the BaGanda comes from Busindi (132).[20] Iron ore is more plentiful in Bunyoro than in the territory of the BaGanda, one of the facts which suggest that iron-working may have been introduced into Uganda from Bunyoro (224);[21] but limonite and other ironstones do occur at Bukonge and Jinja in Busoga, on the Bugaya Islands, at Buvuma, on Kavirondo Bay, and in Ankole (132).[22] For the Kavirondo of Uganda, the Samia Hills between Kavirondo and Busoga yield the best iron ore (132). That used by the Labwor of the Karamojong group is a form of limonite coming from the Tororo Hills in Jie, thirty miles east of Labwor (296). Though the Suk now import a large proportion of their iron as wire, they formerly dug most of their supply from near the headwaters of the Merich River (24).[23] The Bongo and Jur have a great abundance of rich ore, and export iron to the Dinka, Nuer, and Shilluk (121,303) who have little or none.

Angola and the Congo

In the old days Ovambo smiths got their iron from the mines near Ukuanjama in Southern Angola; though nowadays, when access to these mines has been cut off, they rework scrap iron from European trade (110, 154). The Ondulu people in the Bilié district of Angola quarry their ore from a single mountain which is the center of hoe-making for a wide area (217). The Mobambi of the Katanga specialized so strongly in iron smelting that they neglected to exploit rich copper deposits in their neighborhood. The BaNgala imported their ore from the Lulanga River (250). In the Lake Leopold II-Lukenie region, iron ore is plentiful and easily extracted, rich veins being found at as little as two metres below the surface. The Ba-Holoholo, west of Lake Tanganyika, prefer magnetite from the Kabwena Hills on Mt. Kalolo (233). Gaud (100) knows of only one good source of Mandja iron, in Gribingui territory near Kaga Kozamba, where it is quarried on the surface in large pieces. The Ababua get their iron ore — oxides, sometimes occuring in limonite — only in the districts of the Bubwa, Mobalia, and Bokiba, and on the upper Tchimbi (111);[24] while the Kuku (210)[25] derive theirs from mountains in the northeast of their territory.

Central Sudan

The blacksmiths of Kanem formerly obtained superficial ore at Chittati, northwest of Bir Alali, never from the Dagana or from the Dar Kreda (56);[26] while the Kreda people, ignorant of smelting, go to buy their iron from the Arab smelters of the Dagana and the Khozzam, where oxides occur on the surface (56).

West Africa

Though in Park's time the natives on the coast near the Senegal never smelted ore for themselves, but got all theirs from Europeans (200),[27] those of most of interior West Africa enjoyed very rich sources. Forbes (94) estimates that at Dedougou surface soils contain 1.52% of iron; subsoils three feet below the surface, 1.87%; deep soils from native mines, 22.0%; nodular iron ore ten to twelve feet deep, 43.6-55.2%.

Around Kamalia, in Bambara territory, Negroes smelted their own iron and exported it to neighboring states (200), and the natives of Kaarta found an abundance of ore near Khore (213).[28] The Bobo-Dioulasso

15. 160: pp. 326, 695, 638.
16. 97: p. 121.
17. 46: pp. 379, 176, 475.
18. 97: p. 507.
19. 124: pp. 36-38.
20. 132: Vol. 2, p. 664.
21. 224: pp. 381 ff.
22. 132: Vol. 4, pp. 304, 745.
23. 24: p. 18.
24. 111: pp. 233 ff.
25. 210: pp. 181-84.
26. 56: pp. 402, 393.
27. 200: pp. 283-85.
28. 213: pp. 272-73.

district , as we have seen, exported iron to the Ivory Coast (266).[29] At a prominent source a day's journey from Oyo, in Yoruba, all of the villagers work at mining, smelting, or smithing (26). Northern Togo is especially rich in iron, particularly in Western Basari, while ore in eastern Basari is poorer (164). The famous Abotan-Dyor mountain of Banyeri consists almost entirely of iron ore, and has a dark reddish color sharply contrasting with the white quartzite of the surrounding country. Dapper (63) says that in the Kingdom of Bena, north of Torra and Sierra Leona and south of Mandinga, "on connait à la couleur de la terre des montagnes qu'il y a des mines de fer et que ce metal y est plus fin qu'en Europe." One of the most spectacular West African fields lies in northeastern Liberia, on the edge of the Mandingo country, where, according to Johnston (133),[30] "the soil is so ferruginous that it appears in many places to be a solid mass of iron ore, so that the beaten roadways traversed by men, horses,and donkeys shine like polished metal, and are almost impassable in the dry season, owing to the frightful heat which they radiate in the sunshine."

North of the Negro lands in West Africa, iron-working is but weakly developed. Though Tuareg ironsmiths now live within the Bend of the Niger (78),[31] the Sahara Tuareg, living in an area rich in iron ore, smelt none of the metal for themselves, and presumably procured all their iron from the Negroes. Park (200) states this to have been the case with the Moors north of the Senegal.

THE MINING AND PANNING OF IRON ORE

Mining

Iron ore usually occurs so near the surface that shafts or galleries are quite unnecessary, and ancient mining has left little trace. One of the few instances of elaborate workings occurs at Akpafu, in southwestern Togoland, where natives in former times dug more than one hundred winding shafts in the ironstone mountains, some vertical with side galleries, others sloping or horizontal. They hacked out the ore with long-handled, socketed iron celts, and passed it up the vertical shafts in baskets, the bearers standing in notches in the wall of the shaft (214). At Dedougou, in French West Africa (94), miners in the dry season sink pits in the ore-bearing stratum at or near the water level and, tunneling from pit to pit,extract lumps of ore. Another exception is an ancient iron mine near Lusaka (69), perhaps a relic of the same culture which left the spectacular workings for copper and tin in the Transvaal and Southern Rhodesia. An old iron working ten feet deep and forty feet long, has been found twenty miles southeast of Francistown (81). Southeast of the Shimbanza, between the Loango and the Lubuzi,ore outcrops show traces of quarrying by fire (196).[32] Exploration might disclose numerous old iron mines throughout Negro Africa, but they would probably never attain the proportions of the copper and tin mines of the Transvaal.

Panning

The Akikuyu (227)[33] best exemplify "panning" for iron ore in East African sands. They wash it from decomposed granite in a secluded and narrow gorge, where they have deflected a portion of the stream over a surface of cliff detritus so that "its action can be brought to bear as desired against the material of the glacis at any level, and at any point, throughout the greater part of the length of the gorge." This artificial rivulet excavates sand from the detritus and carries it down to the brook below. The woman or child engaged in the panning smoothes out a shallow basin in the hard ground by the stream. The side of this pan nearest the stream has a vertical wall, and is increased in height a few inches by a little fence of sticks and grass with an opening nine inches high in the middle. This opening is temporarily closed with grass. Within the pan, on the side away from the stream, the miner piles about ten quarts of iron-bearing sand. Standing with one foot just outside the opening, and the other in the stream, she rapidly scoops water against the sand pile. Thus the lighter ingredients of the sand are washed away through the little door in the fence, which is periodically opened, while the heavy grains of black magnetite are left on the bottom of the pan. They are finally washed in a gourd and dried on a flat rock. It takes a single miner about half an hour to secure a pint of ore.

The WaItumba obtain their ore by an almost identical method. The women divert a small stream of water through a series of little pits about ten feet apart, each pit lower than the preceding and three feet in diameter. Placing the pay dirt in the pits, they allow the running water to wash the sand and earth away from the ore, which is then dried and winnowed free of stones. The cleaned ore is wrapped in small palm-leaf parcels to be sold for its bulk of corn (151a).

In the following table I have indicated, as far as my notes allow, the kinds of iron ore mined by natives in various parts of Negro Africa, distinguishing between the two chief methods of procuring the ore — quarrying and washing from sand. I regret that in only three cases have I found chemical analyses of the ores, and that the designation given the ore is often too vague for metallurgical comment.

29. 266: pp. 44-45.
30. 133: Vol. 1, p. 492.
31. 78: p. 43
32. 196: p. 205.
33. 227: pp. 79-97.

Occurrence of Iron Ores

Tribe or place	Ore	Washed from sand	Quarried	Reference
Kafir			x	122: p. 247
Lusaka			x	69: pp.418-19
BaVenda			x	137
BaIla			x	242: Vol. 1, p. 203
Kimbokwe near Zambezi River	Nodular	dug from gravels		46
Funze Hills (Kafue region)	Magnetite		x	160: p. 611
WaMakua	Magnetite			97: p. 170
West of Lake Nyassa	Specularite (specular haematite), yellow haematite, magnetite			161: pp.536-37
WaKonongo (Southern BaNyamwezi)		x		256: pp.152-63
Southern BaNyamwezi		x		34: Vol. 1, pp.161-65
Central and western BaNyamwezi			x	256: pp.152-63
Northern BaNyamwezi			x	34: Vol. 1, pp.161-65
Manyema	Fine black specularite			46: p. 475
Pakhundi (eastern Congo)	Haematite		x	46: p. 236
WanItumba		x		21: pp.232-33
WaPare		x		21: pp.232-33
WaKinga	Magnetite; sand and friable brown ore, decomposed gneiss	x		97: pp.167-68
Akikuyu	Black magnetite; some ilmenite; in decomposed granite	x		227: pp. 79-97
Masai		x		132: Vol. 1, p.834 185: p.113
BaGanda	"Hard" and "soft;" haematite		x	132: Vol. 2, p.664 224: p. 381
BaKitara	Hard, black "male" ore on surface (magnetite?); soft, red "female" ore in layers in hill-		x	223: p.219

Occurrence of Iron Ores (cont'd)

Tribe or place	Ore	Washed from sand	Quarried	Reference
	sides (hematite?); always smelted together			
Labwor			x	296
Bari		x		240
Jur			x	
WaLongo, Ngoma Village, Southern	Ferruginous			
Massangano (Lucalla R., Angola)	Black magnetite		x	160: p. 436
BaHoloholo	Magnetite;oxide; limonite		x	233: pp.117-18
BaLuba	Limonite and "richer" ores		x	58: pp.223-25
Lake Leopold II-Lukenie region			x	171
Upper Ogowe	Silica, 22%; manganese oxide, 8.28%; peroxide of iron, 69.12%; water, etc., .50%			73: pp.465-73
Mandja	Limonite: Fe_2O_3, 49.2% (i.e.,34.5% iron); Mn_3O_4, 1.3%; Al_2O_3, 4.8%; CaO, 0.7%; MgO, 0.6%; SO_4H_2, 0.1% P_2O_5, 1.2%; Water and other volatile products, 1.5%; Gangue, 41.6%		x	100: pp.225-32
Ababua			x (2-3 metres below surface)	111: pp.233 ff.
Baya	Pyrites; laterite (poor);"brown ore" (richer)		x	211 115
Bagam	Fe, 27.72% SiO, 56.72% Mn, .88% P .04%			173
Yoruba	Haematite		x (6-8 ft. deep)	27
Western Sudan (Medina, Bammako, Kita, etc.)	Oxide		x	9

Occurrence of Iron Ores (cont'd)

Tribe or place	Ore	Washed from sand	Quarried	Reference
Central Nigerian Plateau	Black haematite and limonite		x	78: pp.11,37
Yatenga	Laterite		x	264: p.218
Foulse (Yatenga)			x	264: pp.543-44
Fouta	Laterite, rich in iron		x	84
Dedougou	Laterite in sheets under surface; nodular limonite. Iron as ferric oxide, 73.79%; metallic iron content, 51.65%; SiO_2, 12.18%; water at red heat, 12.65%; titanium dioxide, .32%; lime (CaO), .08%; magnesia (MgO), .39%; phosphoric acid, .50%; undetermined residues .89%		x	94
Liberia	Ilmenite; magnetite; ochrous ore; specular magnetite			133: Vol 1, p.518

ELEMENTS OF THE SMELTING PROCESS

As I remarked in the second chapter, most modern Negro iron-smelting differs from that practised in the ancient Mumbwa Cave, in that it is performed without a flux and produces a spongy bloom rather than the liquid metal. When we study what actually happens in the furnace, we find that even this elementary process is not as simple as it looks. Rather than merely the heating of the ore so that the iron melts away from the earthy matrix, it is primarily a series of chemical reactions; though, as we shall see, physical reactions are also essential.

Iron ores are usually oxides. The main desideratum in smelting is to place the ore in close contact with some substance which will reduce it, that is, which will rob it of its oxygen and leave metallic iron. Heating with charcoal performs this function admirably, for the carbon of the charcoal burns to carbon monoxide, which takes more oxygen from the ore to form carbon dioxide. This reducing action begins at a very low temperature, probably about 250 degrees or 300 degrees Centigrade. The taller the furnace, however, the more efficient it is for reducing purposes, largely because the carbon monoxide has a greater chance to act on the ore and the unburned charcoal in its passage upward, heating them both and reducing the ore.

The most important physical change, the melting of the iron, normally takes place between 1130 degrees and 1530 degrees Centigrade. This broad range of melting points is due to the fact that the iron, as soon as it has reached about 723 degrees Centigrade, begins to absorb carbon from the fuel, which proportionately lowers its melting temperature. The heated iron also absorbs other elements, especially silicon, phosphorus, sulphur, and manganese, all from the earthy material mixed with the ore.

These elements enter into new compounds with the iron and with each other. One of these compounds, mentioned in connection with the Mumbwa smelting, is iron phosphide; and the presence of more than 0.04-0.06% of phosphorus in this form will make the iron brittle when cold. Most of the carbon occurs as cementite — iron carbide — and since this compound is exceedingly hard and brittle, its proportion and distribution largely determine the physical and mechanical properties of the product.

In modern commercial practice, iron containing 1.7% or more of carbon is called cast iron; that containing less, steel or wrought iron. Cast iron has a relatively low melting point and is not malleable at any temperature; under shock or stress it simply breaks to pieces. Steel, to quote Boylston's definition (39),[1] is "iron which is malleable at least in some one range of temperature, and in addition is either (a) cast into an initially malleable mass; or (b) is capable of hardening greatly by sudden cooling; or (c) is both so cast and so capable of hardening." Unhardened steel which has a total carbon content of less than 0.9% shows, under the microscope, laminae of cementite and pure iron; but if the carbon content is higher, little pure iron is left.

Negroes usually make wrought iron rather than cast iron or steel. Wrought iron is produced in a pasty, not in a molten condition, is malleable, and contains so little carbon that it does not harden appreciably when suddenly cooled. Moreover, it is not homogeneous; it contains particles of slag, the non-metallic impurities of the ore, which, because of the low temperature of smelting, have remained entangled in the iron.

Sometimes, however, Negroes produce steel, either by accident or design. Many more native metallurgists will have to be interviewed and many more specimens analyzed before we can say how often they do so; but I have encountered several references to tempering and puddling — that is, lessening the carbon content of iron by reheating — and both Bellamy (26, 27) for Yoruba and Stanley (245) for the Mashona and the old Zimbabwe culture, have published accounts of Negro steel manufacture and analyses of the product. Bellamy's unique data will lead off my discussion of smelting methods; and Stanley's, which include microphotographic sections of native steel and iron, will be more intelligible if presented in a general discussion of Negro steel metallurgy, after we have finished with the grosser mechanical aspects of the smelting process.

Obviously the character of the ore may affect the process and the product; some ores, for example, usually having so much lime with them that they are self-fluxing and tend to produce cast iron. If you turn back to the table in the chapter on iron ores and mining, however, you will see how little information we have on this point; and I can only side-step the issue by suggesting

1. 39: p. 32.

that, to judge from the empirical data, none of the iron ores used by Negroes are intractable enough to alter the smelting technique very greatly.

Haematite — iron oxide occurring in a number of colors and forms — is the commonest and, at least from the modern commercial standpoint, the most profitable. It has usually only a very small proportion of phosphorus, thus favoring the production of wrought iron or steel. Magnetite, black and lustrous, ranks next as a favorite of modern smelters. Though magnetite usually requires roasting, this may be accomplished within the smelting furnace itself. Limonite, a hydrated form of haematite, bears a smaller proportion of iron, and though it is usually low in sulphur it often contains a considerable amount of manganese. All of these ores abound in the Negro area, where others, less often brought to modern commercial smelters, are also used: pyrites, laterite, and ilmenite.

NEGRO SMELTING TECHNIQUES

I now ask the reader to follow me through a number of smelting operations, those most fully described in my notes. These descriptions, though disconnected and tedious, will help him to understand the table and the general discussion which follow. In order to give some faint semblance of continuity to this set of random examples, I shall first describe smelting in the large furnaces of the northwest and of Rhodesia; later, the operation as practised in the small furnaces and pits of other areas.

Large Furnaces

Significantly enough, we find one of the most advanced iron-smelting techniques in a small community where all the members participate in the industry, and which supplies native markets over several hundred miles. This is the Yoruban village of Olaigbi, on the south bank of the Omi River a day's journey from Oyo (26). Though its inhabitants numbered less than 125 in 1904, they knew of no other iron smelters, and sent their wares to Oyo and Ibadan, and as far south as Ojebu-ode. They say that they moved to their present location about 1898 from near Menea village, south of Oyo, because the ore here is better than that in their old home.

They mine at a depth of six or eight feet, digging down through gravels of nodular haematite to a laminated shale bed which encloses the ore they desire, a very siliceous haematite. Having taken this out in pieces weighing three or five pounds, they roast it all night over fires of green timber, placing about a barrow-full of ore on each fire. Women and children then pound it fine in ordinary wooden mortars such as they use for grinding grain, screen it in open-work basketry sieves, and take it to the river for panning. On the river bank women dig holes two feet deep, fill them with water to within a foot of the brim, and then, standing in the holes, wash the ore in calabash trays with a circular, oscillating motion, allowing the lighter matter to spill over the edge of the tray. Other women wash the remaining heavy granules by sluicing in clear water and agitating them till the water drawn off no longer shows color. They then take the ore to the smelting furnace, in which it is placed while still wet.

The village has eleven mud-walled smelting houses, each twenty-five feet long, sixteen feet wide, lying lengthwise east-west, with a door at each end. Between the wall and the lofty, thatched roof, ample space is left for light and ventilation. The furnace, seven feet in diameter, measures nearly five feet from top to bottom, and is sunk about a foot below the floor of the house. Its door, facing the house door and opening into a broad excavation in the floor of the house, occupies about a quarter of its circumference; the rest being taken up by seven rough counterforts alternating with six openings, each opening about a foot and a half high and eight inches across, sloping inwards and downwards toward the center of the furnace. The domed top has at its center a hole about nine inches in diameter. A short distance below the curve of the top, the furnace is bound with a twist of creepers to prevent cracking under heat. At the center of the furnace floor, an aperture three or four inches in diameter gives access to a short tunnel which terminates in a pit just inside the rear door of the house, and is drained of rainwater by a branch tunnel which passes out under the wall. Other furnishings include a small clay oven for firing the ventilating tubes, a clay bin for the ore, stacks of charcoal, calabashes of flux and metal, tools, mortars and pestles, and are all usually kept around the wall.

Smelting, which begins at daybreak and lasts till the evening of the following day, proceeds as follows. Having modelled on wooden rollers a set of ventilating pipes, two feet long and one inch and a half in diameter, and partially baked them, the smelters place two of these, one above the other, in each of the smaller apertures in the furnace wall, slanting them inward and downward, building charcoal around them within the furnace, and luting them tightly into place by a two-inch thickness of clay. They then close the tunnel entrance in the bottom of the furnace with a cone of damp sand. Having started the fire with a few live coals, they lute three pairs of ventilating tubes into the furnace door, arranging them like the other tubes around the furnace, sealing them securely into place and covering their inner ends with charcoal. Air now enters the furnace only through the eighteen ventilating pipes and leaves it through the hole at the top; and since the total area of outflow is less than half that of intake, a forced draught is produced.

As soon as the fire has gained suf-

ficient strength, the smelters throw into the furnace about two bushels of charcoal and five pounds of selected clinker from a previous smelting. Two hours later, this flux is drawn off through the tunnel at the bottom of the furnace, and the same amounts of charcoal and clinker are put in. This process is repeated a third time, making a total of six hours of preparatory fluxing before the furnace is deemed clean enough for charging with the ore. It apparently serves to melt away any old accretions of slag which may encumber the furnace walls.

The first load of ore, about five pounds, is added after five more pounds of clinker and two bushels of charcoal have been thrown in. This combination is repeated ten times throughout the smelting period. The quantity of ore put in at each charge gradually increases from five to thirty-five pounds, this maximum being reached on the eigth charge and maintained on the ninth and tenth. Two or three hours elapse between any two charges, but an interval of five hours is allowed between the tenth charge and the opening of the furnace. Before each charge a man descends into the tunnel and pierces the plug at the furnace bottom with an iron pricker to draw off the slag. Clinker from the last three drawings — that is to say, the slag drawn off before the ninth and tenth charges and before the extraction of the bloom — is set aside to be used in a subsequent smelting. The slag most valuable for future use is the very last which is drained away. This will certainly be used; while the slag drawn off before the ninth and tenth charges is set aside for examination and selection in daylight.

With a wooden crowbar shod with iron the smelters finally break away the clay seals from the smaller apertures; then discard the ventilating tubes, open the furnace door, and quench and rake away the charcoal from the bloom, which lies as a red-hot cake weighing between seventy and eighty pounds. They drag this out by means of a loop of green creeper, and chop it into convenient sizes for future work.

Harbord (26) has reviewed the processes described above and explained several technical phases. The roasting of the ore, he says, drives off the combined water and converts ferrous oxide to ferric. Grinding and washing reduce the siliceous residue from 43% to 14% and increase the percentage of iron. The clinker used as a flux is ferrous silicate, that selected as the best containing the least silica. This not only helps to seal the metallic iron against oxidation, but also adds to the final yield much of the iron which the clinker itself contains, and which would otherwise be lost.

"So far the metallurgy of the process is concerned," says Harbord, "it is similar to most direct processes, the metal being reduced by charcoal, and then partially decarburised in the same furnace by means of fusible oxides, which also largely dephosphorise the metal. It is interesting to note how complete the dephosphorisation is, as the washed ore containing 0.033 per cent of phosphorus would, if smelted in a blast-furnace, give a pig iron with approximately 0.06 per cent of phosphorus, but, under the conditions prevailing, of comparatively low temperature in the presence of oxidising fluxes, this is reduced to 0.01 per cent."

Thus the siliceous flux used by the Yoruba probably has the opposite effect from the bone flux employed by the ancient Mumbwa smelters. Essentially an iron silicate compound with a low melting point, which acts as a good solvent for other oxides, it removes phosphorus from the iron and tends to produce wrought iron or steel; whereas the Mumbwa flux seems to have added phosphorus to the metal and to have helped to produce cast iron. It appears that the two fluxes served two entirely different purposes: that of the Yoruba, to oxidize the phosphorus and some of the carbon; that of Mumbwa, to form a light and fusible slag.

"It is probable," continues Harbord, "that the metal never collects in the fluid state on the bottom of the furnace; but as it is reduced and falls through the bath of oxidising flux, it is partially decarburised, its melting point raised, and the temperature is just high enough to enable it to gather together in the form of a metallic sponge, from which the fluid slag can be tapped off from time to time."

Harbord explains that when the smith repeatedly reheats and hammers the iron he is "puddling" it, removing most of the remaining silica and reducing the carbon content from 1.6% to 1.0%. The finished metal tool is "really a puddled steel, low in sulphur and phosphorus." Harbord suggests that the smith can vary the decarburisation according to the purpose of the tool — a conclusion unsupported by Bellamy's published description, but, if true, placing Yoruban metallurgy somewhat above the general Negro level.

Harbord tabulates the analyses of the ore, fluxes and iron as shown on the following page.

Our scrappy data from the rest of West Africa do not allow us to state definitely that the Yoruba process is unique; but we can say fairly certainly that the use of fluxes in this general area is rare. If it were common, some of the following descriptions would include it.

At the end of the eighteenth century, Mungo Park (200)[2] found the Bambara or Mandingo at Kamalia smelting iron and exporting it to neighboring states. They used a cylindrical clay furnace, ten feet high and three feet in diameter, bound above and below with withes to prevent rupture under heat. The bottom was a shallow pit in the ground. Seven holes just above ground level,

Analysis of Ore Before and After Treatment

	Ore as mined	Roasted ore, before grinding	Roasted and pulverised ore before washing
Siliceous residue	43.00%		43.40%
Peroxide of iron	48.60	53.10%	53.42
Protoxide of iron	3.30	1.00	1.00
Oxide of manganese	traces		traces
Alumina	0.20		0.77
Lime	0.10		0.10
Magnesia	traces		traces
Phosphoric acid	0.13		0.102
Sulphur			0.028
Loss on ignition (water, organic matter, carbonic acid, etc.)	4.50		
Metallic iron	36.67	39.00	38.20
Phosphorus	0.057		0.045

Analysis of Washed Ore

	Ore pulverised and washed ready for furnace	Tailings
Siliceous residue	13.96%	56.40%
Peroxide of iron	85.09	
Protoxide of iron	0.57	
Oxide of manganese	traces	
Alumina	0.50	
Lime	0.50	
Magnesia	traces	
Phosphoric acid	0.080	
Sulphur	0.014	
Metallic iron	59.90	28.50 (total metallic iron)
Phosphorus	0.035	

Analysis of Fluxes

	Clinker used as a flux (the last which comes away before the furnace is opened)	Selected clinker from first runnings of furnace	Dross clinker sent to spoil heap
Siliceous residue	38.00%	49.84%	52.00%
Peroxide of iron	10.00	5.00	6.14
Protoxide of iron	38.43	43.65	33.68
Alumina	7.60	0.20	2.50
Lime	1.90	0.56	3.46
Magnesia	0.50		0.68
Phosphoric acid	0.129		0.180
Metallic iron	36.70	37.50	30.50
Phosphorus	0.056		0.081

Analysis of Native Metal

	Smelted iron broken up in a convenient size, in which state it is sold to smiths	Piece of native metal puddled by smith at Oyo	Chisel
Carbon	1.670%	1.022%	1.080%
Silicon	0.252	0.026	0.093
Sulphur	0.000	0.006	0.006
Phosphorus	0.010	0.012	0.018
Manganese	trace	trace	trace

2. 200: pp. 283-85.

with three clay tubes plastered into each hole, gave ventilation, which was controlled during smelting by opening and shutting the tubes. The smiths formed these tubes by pastering a mixture of clay and grass around a smooth wooden roller, withdrawing the wood, and drying the tubes in the sun. A pair of goatskin bag bellows was used to start the fire.

Into the furnace the smelters first put a small amount of dry wood and covered it with charcoal. The ore, dull red with grayish specks, was broken into pieces the size of hens' eggs and placed in the furnace between alternate layers of charcoal. The furnace was then lit through one of the ventilating tubes and fed with more charcoal at intervals. Smelting lasted for forty-eight hours. The large, irregular bloom, sonorous and of a granular fracture, with much charcoal adhering, yielded a "hard and brittle" iron or steel, which required "much labor before it could be made to answer the purpose."

This description, except for the lack of a flux and a drainage tunnel, sounds suspiciously like the Yoruba one, with the seven ventilating holes, the tubes modelled on wooden rollers, the binding of withes to prevent the furnace from cracking, and the brittle product, rich in carbon, which apparently requires puddling before it can be forged. But let us see what other observers have to say.

Delafosse's account of the Senoufo (71) contains several unbelievable items. He says that although Senoufo smelting furnaces vary locally, they are usually globular, or conical with rounded tops, open at the top for charging and with three or four apertures at floor level. Each of these apertures admits a pair of clay tubes, held in place by a kind of sliding pane, which are inserted as soon as the reduction process has begun.

After quarrying, the smiths break up the ore by means of granite blocks. They prepare their charcoal by burning wood in small cribwork piles covered with earth and green plants.

So far, so good. But Delafosse states that as the molten iron drops to the floor, it runs into the tubes, where it cools and solidifies. The smelters later withdraw the tubes and break out the bars of very impure, spongy iron. Having quenched it in water they beat it for hours between granite blocks till it is smooth and free from scoriae. They then reheat it to redness, plunge it again into cold water, and hammer it on an anvil. It contains some carbon, and is "a form of steel."

The puzzling element here is the casting in clay tubes, which implies an iron too liquid and too high in carbon to be later beaten into shape, and contradicts the author's statement that the product was "spongy." The repeated heating and hammering of the iron would not only free it from slag but would reduce some of the excess carbon which it would certainly take on if sufficiently liquid to flow into the tubes. But the whole process, as described by Delafosse, is a very difficult and bad one; and Mr. Yatsevitch agrees in my suspicion that Delafosse mistook the ventilating tubes for moulds.

Natives at Dedougou, in the Western Sudan (94), smelt iron in a tapering tower of grouted clay sometimes as tall as twenty feet and as much as eight feet in diameter. This may stand either on ground level or in a pit in which the smelters work, the sides of which are then built up with slag refuse to the top of the furnace and the structure roofed over with a platform of poles and tamped clay. A hole in this platform frees the pit of poisonous gases. Six clay ventilating tubes, two feet long, moulded on straw forms and dried in the air, are inserted slanting downwards into apertures evenly spaced around the wall, about two feet above the floor. An opening opposite the main door aids in extracting the bloom, both of these entrances being closed during the smelting. A trench is dug up to the front door to receive the molten slag.

In preparation, the smelters clean the furnace bottom, arrange a fresh bed of ashes, and repair the tuyere emplacements with a mixture of clay and ash. Having sprayed the charcoal with water, they mix it with the ore — nodular limonite broken to pieces the size of hens' eggs — in the ratio of six or eight parts of charcoal to one of ore. When they have assembled this mixture on top of the shelter, they kindle the furnace with dry millet stalks and pour charcoal on the smoky fire. They then insert the ventilating tubes, close the door with damp earth and ashes, and pour in the mixed charge. This at first nearly smothers the fire; but the furnace fills with gas, and when the smelter ignites this gas with a torch it strikes back through the charge with a blue flame which brings the furnace into action. The fire is then left alone for the night to burn under its own draught, while the reduced iron trickles down into the bed of ashes and accumulates as a ragged bloom, weighing about ninety pounds, beneath the lake of slag. In the morning the smelters open the front door, draining the slag into the trench. Having opened the rear door, pried the bloom loose, and pushed it out through the front, they cool it with water and clean it of adhering slag, ash, and charcoal. They later break it into pieces, which they heat in an open fire under draught from the bag bellows, and work free of charcoal and slag. Ore, slag, and crude iron at Dedougou analyze:

	Ore	Slag	Crude Iron
Water at red heat	12.65%		
Iron as ferric oxide	73.79		
Metallic iron	51.65	37.23%	92.8 - 96.11%
Silica (SiO_2)	12.18	32.59	

	Ore	Slag	Crude Iron
Titanium dioxide	.32		
Lime (CaO)	.08		
Magnesia (MgO)	.39		
Phosphoric acid	.50	.43	.04
Residues undetermined	.89		
Combustible charcoal			.33 - .3C
Insolubles (slag)			3.23 - 2.38

Here we have a much purer wrought iron than in any of the foregoing cases. Its low carbon content can only be explained by a smaller proportion of charcoal used in the smelting. Certainly the furnace is tall enough to produce molten cast iron if the natives desired it. Typically for Negro smelting, much iron is lost in the slag, for there is no lime flux to combine with silica and other constituents of the ore and release more of the metal. Wrought iron from a native forge at Dedougou analyzed 99.10% pure iron.

Archinard (9) has described smelting in the district of Kita, Bammako, and the Bakoy River in the Western Sudan, where it seldom proceeds more than once a year, just before the rainy season, when agricultural implements are made and repaired. The clay furnace, two or three metres high, forty to fifty centimetres in diameter near the base, "presents the aspect of two truncated cones placed one on the other, united by a bulge in the upper cone." Several poles propped against it on the outside help to support the walls. The interior is likewise biconical, with the lower cone sometimes enlarged at its middle. Beneath lies a pit fifty to sixty centimetres deep at the center, sloping gently to ground level at the furnace door, to facilitate the removal of the bloom. The tuyeres, of mixed clay and straw, incline downwards through openings five to ten centimetres in diameter in the furnace wall, at about the level of a man's waist. The door, which remains open throughout the smelting, plays a large part in ventilation, but the builders do not take advantage of the prevailing wind, and face their furnaces in every direction. The slag flows out through another large hole, which is blocked with clay during the smelting.

The ore — usually haematite containing 70% of iron — is placed in the furnace between alternate layers of charcoal, and smelted in about fifteen hours. As soon as the smelters extract the spongy bloom, they beat its outer crust away and plunge it into a hole full of water; after which they reheat it and beat it free of slag. The low percentage of carbon in the iron probably prevents the sudden cooling from turning the bloom to hard steel.

An unusual furnace construction has been reported from Dande village, near Boulebane on the road to Bakel, again in the Western Sudan (213).[3] Here the smelters first dig a pit eighty centimetres deep and dry the walls with burning straw. They then refill it with charcoal and straw, cover it with a layer of clay, pierce this layer at the center, and place upon it charcoal, straw, and wood, the latter in pieces leaning against each other. It is hard to see the value of the clay partition, especially since Raffenel's description leaves much to be desired. The partition might possibly prevent the iron from further carburisation after it has dropped to the bottom of the furnace. Having built the fuel up to a certain height, the smelters add the ore; then build around this whole charge a clay furnace three and one-half or four metres high, in the form of a truncated cone, pierced at the bottom with several ventilating holes. They fire and feed the furnace for eight or ten hours, demolish it, and extract the bloom. Though this product is very good, they smelt iron of a somewhat better grade in a small crucible, in which the ore, mixed with charcoal, is reduced under draught from a set of small bellows. This probably allows a more careful control of the carbon content.[3a]

Smelters at Akpafu, in southwestern Togoland (214), employ the technique common in the interior of the Western Sudan. The furnace, with a door at the base and a bottle-shaped neck, is four feet high, three feet in diameter; but owing to the thickness of the walls the chamber has a breadth of only a foot and a half. Six holes near the base give ventilation. A footway around the furnace is guarded from rainwater by a low mud wall, and covered with a low, flat roof through which the chimney projects and on which the smelters may work. A wooden slab may be placed over the chimney to keep out the rain. The same general type of furnace is used by the Lolobi (127) of Togo.

The smelters begin by filling the furnace with charcoal, lighting the fire at the door, and closing the door with clay, leaving only a small duct through which the slag may flow out. They then pour broken ore through the chimney and cover this ore with charcoal. They smelt for about twelve hours, occasionally poking the fire through the ventilating holes. When they judge the process

3. 213: pp. 56 ff.

3a. Captain Wild, who finds the remains of normal above-ground smelting furnaces all over the Gold Coast and Ashanti, describes at Aborposu, Ashanti, a pit eight feet deep which he believes was also used for smelting iron. Since it shows no means of draining off the slag, ventilating, or extracting the bloom, and since the local natives all explain it as an old grain bin, Captain Wild's belief may be doubted. In the bottom he found good samples of slag, but these may have dropped into the pit accidentally, since others were strewn around the ground not far from the pit's mouth (305 c).

complete, they break the clay from the door and rake out the small lumps of iron which have sunk to the bottom.

The smelters at Basari in Togo (127) use a cylindrical furnace three or three and one-half metres high, to the top of which they climb by a stubby pole leaning against the outside. Before charging, they cover the floor with sand to keep the slag from harming the walls, and plug with clay stoppers the eight or nine ventilating holes entering near the bottom of the furnace. The charge is elaborate, poured in from the top in the following order: two baskets of charcoal, several armfulls of sticks about three centimetres thick, two baskets of charcoal,

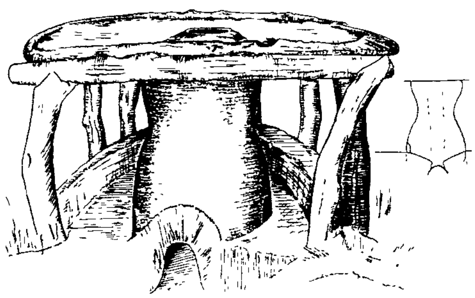


Fig. 2. Furnace: Akpafu (redrawn from 214).

seven gourds of iron ore, one basket of charcoal, five baskets of iron ore, some burning charcoal, and one or two baskets of cold charcoal: giving a total of 1.4 cubic metres of charcoal and 120 kilograms of ore. The fire, thus started from the top, burns without bellows for two days, regulated only by the opening and closing of the holes. On the third day the bloom falls to the bottom with a loud crash. The smelters pull it out and at once throw sand into the furnace to protect the floor. Though the bloom weighs between 25 and 30 kilograms, it is studded with pieces of charcoal and slag and contains little more than 20 kilograms of usable metal, 24% of that actually in the ore. When a smith has beaten and picked out the impurities, he "moulds" the iron into balls about the size of the fist, covers these with jackets of dried grass and clay, and leaves them in his fire for several hours. This slow heating away from air can only serve to allow the iron to absorb more carbon from the free charcoal embedded within it, thus becoming harder and possibly more susceptible to tempering; while the clay casing prevents oxidation of the metal.

The people of Bagam district in central Cameroon (173) smelt iron in a large rectangular furnace covered by a gabled hut. The furnace stands in an artificial hollow, with its back of bed-earth and its other three sides of beaten clay mixed with chopped grass. Its external dimensions are four feet across the face, five along the sides; but the thickness of the walls diminishes the chamber to scarcely two by four. A slope of ground leads down to the entrance. At the top are the hole for charging and the tube for the escape of gas, while two pairs of bellows rest on solid earth at the rear, with their two long tuyeres leading down into the furnace.

After each operation the smelters coat the interior with a light wash of clay, beat the fire-bed hard with a wooden mallet, and lay upon it a thick bunch of dried plantain leaves to accommodate the tuyeres, which are luted into the top of the furnace. They then spread a layer of smelting refuse over the plantain leaves, and close the door with pieces of discarded tuyeres plastered upright against its outer border, with two small holes pierced between them to act as supplementary gas escapes.

Having kindled the fire by throwing a few live coals on the plantain leaves and blowing them gently to a blaze, they gradually feed in the charge — consisting of half ore and half charcoal, or some kernels if charcoal is scarce — and work the bellows at full pressure for twenty-four hours. Without making any tests of the products, they then withdraw the bellows, prise out the tuyeres, and throw water on the furnace front. After half an hour, they break the clay bars from the entrance and drag out the bloom with a hook. It emerges as two long, irregular masses, connected near the ends by a short bar, and weighs about sixty pounds. The smelters break it up with hammers and remove the lumps of slag. As soon as the bloom has been extracted, they prepare the furnace for the next smelting, since iron is in constant demand. Bagam ore and slag analyze:

	Ore	Slag
Fe	20.72%	52.37%
SiO	56.72	16.04
Mn	0.38	2.37
CaO	0.00	4.22
MgO	0.00	0.60
P	0.04	0.36

The loss of iron in the slag is pathetic.

The several Baya sub-tribes in Cameroon display several variations in the smelting technique (115, 272).[4] The Bogoto are the most divergent, as the only known tribe in the southern and eastern Cameroon who use no bellows, but six clay ventilating flues, and take more than twenty hours to smelt one batch of ore. The other three sub-tribes noted — the Baya-Kaka and Baya-Buli in the south, the Baya-Kala in the north — employ a set of three drum bellows blowing into a central tuyere, and smelt in considerably less time: the Baya-Kala in five and a half hours, the Southern Baya in nine. The Bogoto

4. 272: pp. 166-80.

in Mbaui, near the Baya-Kaka, have adopted the technique used by these neighbors. Both the Baya-Kala and Southern Baya have furnaces of unusual forms (272), with more than one furnace in a smelting hut for greater sociability and production. These furnaces are also unique in being built around a central post which forms the chief support for the conical roof of the hut; whereas the Bogoto smelting hut is rectangular and contains two furnaces at most.

flaring mouth. More charcoal is added at intervals during the smelting, which usually lasts from the middle of the afternoon till late the next morning. A hole is finally thrust in the door to allow the slag to flow out, the door broken entirely open, and the bloom, about the size of a child's head, dragged out and away.

The southern sub-tribes, especially the southern section of the Baya-Buli, are the

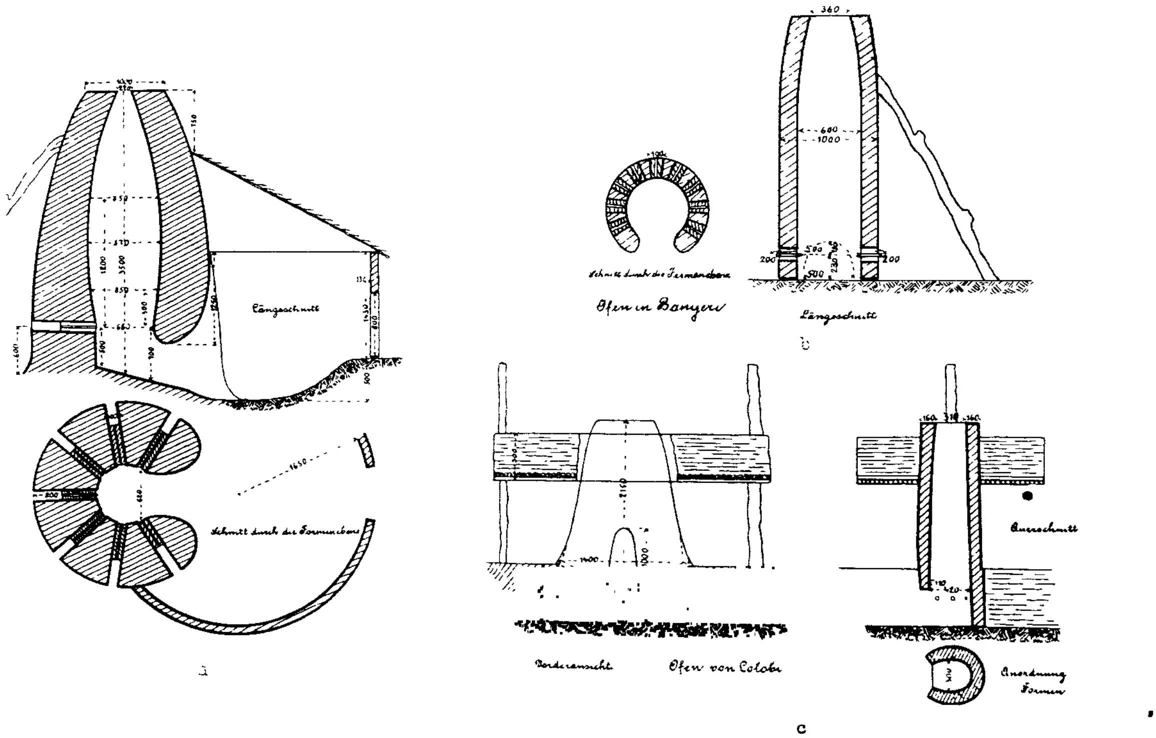


Fig. 3. Furnaces in Togo. a, b, Banyeri; c, Lolobi (after 164).

The Bogoto furnace is bottle-shaped with a narrow neck broadening at the mouth, and is built over a pit which narrows toward the bottom. It has a semicircular door at ground level, and four smaller openings just above ground for the ventilating flues. A sloping trench is dug down to the door for convenience in working and for dragging away the bloom. One Bogoto furnace observed at Ssengotu is buttressed with stones up to ninety-five centimetres above ground, with ropes tied around them; and its fourteen ventilating flues, two of them in each hole, project upward eighty-five centimetres to the roof of the hut.

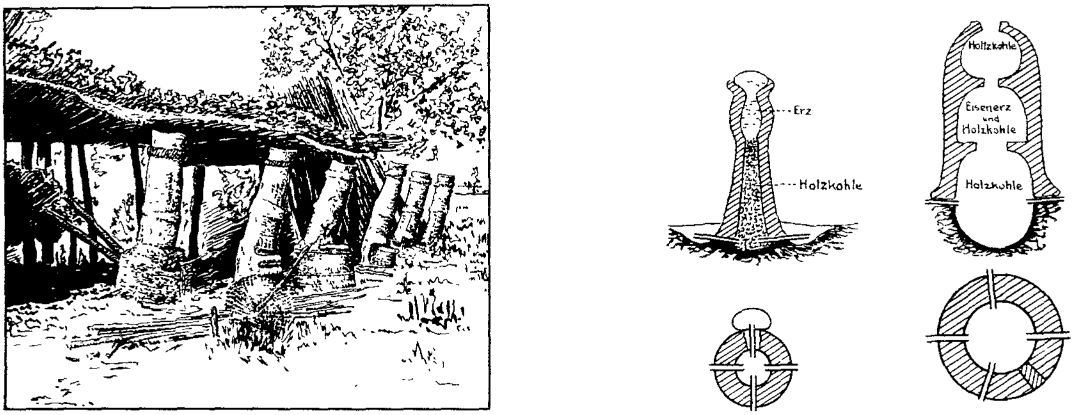
Before charging, the pit is heavily lined with a mixture of water and black earth. The tuyeres — most of them newly made, though some of the old ones may be used again — are wedged into place in the five openings by means of old tuyere pieces; and the door is plastered up, with one tuyere stuck into it. The furnace is then nearly filled with charcoal, and a pile of broken ore is heaped over this, resting on the

most active iron-smelters of the whole Baya group, smelting so much iron that they can sell it very cheaply. Poupon (177), in writing of the Baya in the M'Bimou district — which, so far as I can gather, is in the southern part of the Baya area — says that they smelt iron in a pit filled with alternate layers of charcoal and pyrites, with a pair of drum bellows on each side. Harttman (115) remarks that laterite is the most common Baya ore, but that "brown ore" (haematite? pyrites?) is somewhat richer. Tessmann (272), however, gives the following account of the Baya-Baka, implying that it holds also for their neighbors, the Baya-Buli. As I have remarked, the furnaces are arranged in a round hut with their backs to the post which supports the conical roof. They are united by a bank of clay which makes a continuous platform around this post. Each is pot-shaped, one metre high and half a metre broad, with walls six centimetres thick, and encircled by an iron band which is bound by cords to three long upright stakes, one behind and two at the sides. It may have either a lozenge-shaped or a lens-shaped

mouth, and is named accordingly. To close the furnace a wall of earth thirty centimetres high is built up below and in front of the door, with its two ends meeting the furnace. Against the front of this is plastered a lump of clay to support the funnel-shaped tuyere, into which blows a set of three single-chambered drum bellows, adjusted on a horizontal framework of sticks and withes. Dry grass and charcoal are set in the hollow formed by this little wall, before and beneath the tuyere mouth, and the tuyere luted firmly in place as the little wall is built up to the top of the furnace door.

the bodies of clay rather than wood and work their diaphragms by skin loops instead of sticks. The bellows blow into a funnel-shaped tuyere, about sixty centimetres long, with a larger mouth than that of the southern form, the mouth being supported by an old tuyere placed upright just outside the furnace door. Before each operation, the smelters repair the furnace, close the door with slabs of clay, and lute the tuyere firmly in place between them.

The most significant variation, however, is in the handling of the ore. Instead of



a b c

Fig. 4. Furnaces. a, Lobi; b, Jur; c, Bongo (redrawn: a, after 52; b, c, after 237).

The smelters charge the furnace three-quarters full of charcoal; then fill it with broken ore, and light the fire by a live coal thrust through the tuyere, the little pile of grass and charcoal acting as tinder. For about nine hours, relays of men pump the bellows skins up and down with long sticks, after which they break the door open and haul out the bloom.

Among the Baya-Kala in the north, we find iron-smelting only in a small territory west and southwest of Buar (272). The smelting shop, a poorly-built, round hut with a conical roof and a central post, usually stands near the iron mines at some distance from the village, and close by a stream, in which the powdered ore can be washed and the bloom cooled. The furnace has a semicircular ground plan, with its flat side to the front and its curved side near the central post of the hut. It is 2 metres high and 112 centimetres broad, though its very thick walls allow a breadth of only 36 centimetres to the chamber. The door is 36 centimetres broad and 48 centimetres high.

Like the southern Baya, the Baya-Kala use a set of three separate-chambered drum bellows fastened together; but though they make them of the same shape, they fashion merely breaking it up, as do other Baya smelters, the Baya-Kala grind it to a fine dust, wash it twice in the stream on two successive days, dry it thoroughly, and mix it with the bark of a certain root which has probably only a magical value. Having filled the furnace with charcoal and adjusted the bellows, they kindle the fire and begin to feed in the ore by handfulls. As the fire sinks, they add more ore and charcoal. Blue flames burn away the gas escaping from the top of the furnace and from the chinks around the tuyere, and the smelters relight the gas if these flames go out. After five and a half hours, they break down the door and take out the bloom. The speed of this smelting is probably due to the powdered condition of the ore.

Though all of the Pangwe (269)[5] probably used to smelt their iron, only those south of the Kampo, and a few of the Ntum, have practised the art within recent years. The chief smelting places are in Woddo and Kje districts and are rare in comparison with the available sources of ore.

The smelters dig the brown ore from the surface of the ground and bring it to town in baskets. It contains 67.98% of iron oxide, 11.82% of clay, 8.21% of silicic acid,

5. 269: pp. 224-39.

6.97% of titanic acid, 1.03% of manganese protoxide, and less than 1% each of water, sulphur, magnesia, and other impurities. Titanic acid deters the smelting process, since it creates an intractible slag. The smelters prepare the ore by breaking it up, roasting it for four hours over a hot fire, and breaking it to still smaller pieces.

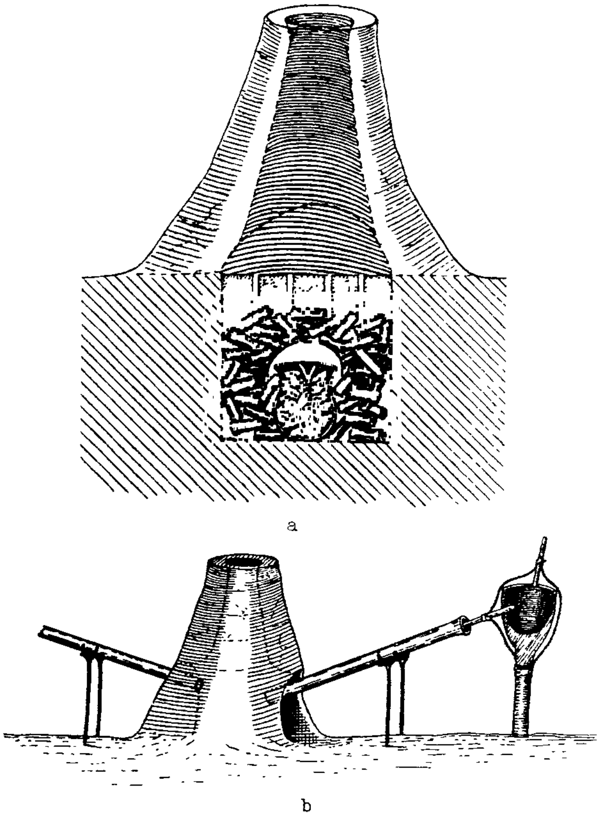


Fig. 5. Furnace: Ungoni. a, Section of smelting furnace, showing "medicines" at bottom; b, Pedestal bellows.

The gabled smelting-hut is three or four metres high, with the ridge-pole supported by two posts. The furnace is erected over a pit 78 cm. deep and 1.86 m. broad, at the bottom of which is a chamber 60 cm. deep for the smelting "medicines." After filling the pit with umbrella leaves, so that charcoal and other refuse can be more easily removed after the smelting and the "medicines" kept cool and clean, the smelters plant a circle of banana or plantain limbs, five or six feet high, around the pit to form the walls of the oven. They set these posts very close together, tying them together with the leaf-stem bark of the raphia tree and fastening them by ropes and pegs to a circle of thick stakes on the outside. They then bind the furnace with cissus vine above and below, and carefully fill the interstices with small stems. Having cut holes in the furnace near ground level, by making adjoining notches in pairs of posts, they insert in these holes sticks about 1.25 m. long, covering the inner end of each stick with a piece of plantain leaf sheath and supporting it with a piece of plantain branch, so that after the charcoal has been put into the furnace the sticks can be withdrawn and the tuyeres freely inserted in their places.

The furnace is now ready for charging. A man climbs down inside it and fills with charcoal the spaces between the sticks; then builds up the charcoal charge, lining the walls with two layers of plantain leaves —

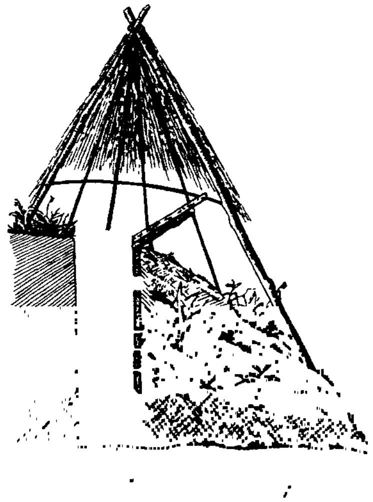


Fig. 6. Furnace: WaMakua (after 97).

the outer layer perpendicular, the inner layer horizontal — to preserve the walls from too rapid heating. When he has set the charcoal to a depth of sixty or seventy centimetres, he places the ore upon it, leaving between ore and furnace wall a space which he fills with charcoal. He then adds charcoal as far as the top of the furnace, leaving in the center of the charge a funnel-shaped space. The sticks are then pulled out of the holes and the long clay tuyeres inserted. Each bellows nozzle is held firm between two short stakes, its end reaching to within three centimetres from the broad end of the tuyere. The fire is lit by a glowing coal pushed through a tuyere, and the bellows begin their work.

Pangwe smelting usually lasts about eight hours, say from one o'clock in the afternoon till nine or ten in the evening. Next day the smelters demolish the furnace and take out the cooled slag, which they break up for use as shot, and chop up the bloom into convenient pieces for forging and trade.

From an unspecified tribe "on the plateau near Lake Chad" (180) come photographs and a brief description of a smelting process in which a limestone flux is employed in furnaces faintly reminiscent of the Baya-Baka form later to be described. Here smelt-

ing is done only intermittently, two weeks' work supplying enough iron for a year. A row of furnaces, each about fifteen inches in diameter, is cut in a bank of calcareous tufa, with horizontal holes tunneled through to accommodate the ventilating flues. The latter are made by laying a grass mat on the ground, plastering it with mud, rolling it around a tapering stick about four inches in diameter, plastering this roll again with mud, and standing it on end till the mud dries, when the stick is withdrawn. "A lit-

Fig. 7. Furnace: BaUshi. The furnace charged with ventilating tubes in place (redrawn from 13).

tle fine limestone" is added to the ore and charcoal charge. Both iron and slag are extracted at the bottom of the furnace.

Turning south into the Congo, we find a good description of iron-smelting among the BaSakata in the region of Lake Leopold II and the Lukenie River (171, 22), who are at present the only tribe in this neighborhood who practise it. The BaSakata build their furnace around a funnel-shaped framework of withes set in the ground, the base of this framework being about forty centimetres in diameter, the top from a metre to a metre and a half. They coat this with pottery clay, applying a new layer each day for several days. Around this they then build another withe framework, and fill with clay the space between the two structures. The furnace is now a truncated cone about two and a half metres high, having a basic diameter of from three to five metres and an upper diameter of from two to two and a half. The internal bottom is an excavated basin from ten to fifteen centimetres in depth, from which a broadening furrow leads down and out to the door of the furnace, an oval opening about forty-five centimetres long and twenty-five high, which may be closed with a thick slab of clay. At its base the furnace is pierced with several smaller oval openings for tuyeres. Over the whole the smelters construct a wind-proof hut with stout walls of poles, fitted with a sliding door. The master-smelter fills the furnace with dry wood and lets it burn for a day to bake the internal wall.

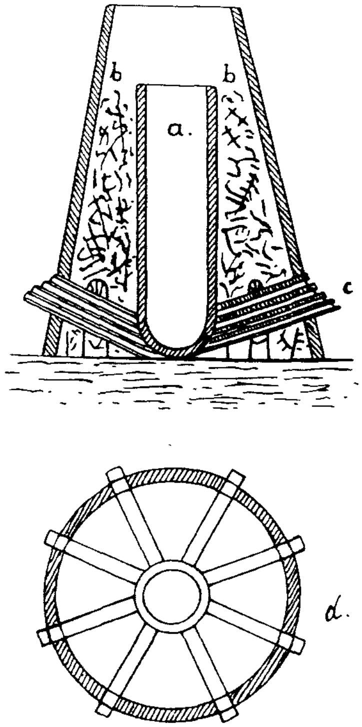


Fig. 8. Furnace: Katanga (193, after Lemaire).

Into it the smelters pour first two or three baskets of charcoal, then a basket of mixed charcoal and broken ore, two parts of the former to one of the latter. The master then lights the fire from the bottom and the four sets of bellows begin their work. From time to time, as the ore is reduced and the fire burns low, more charcoal and ore, mixed four to one respectively, are thrown in. Smelting lasts for about forty-eight hours without interruption. I cannot make out from Maes' description whether the furnace is demolished to extract the bloom. Since he writes as if it were built anew for each smelting operation, and since the iron could not be taken from the door of the furnace unless it had flowed out the narrow aperture in a very molten state, one would guess that this is the case. On the other hand, the furnace is so large and so solidly constructed as to suggest its use for several if not many operations.

Turning to the southeast, we find several accounts from tribes of the same general region as our oldest iron-smelting site: one

good one for the BaUshi (13), about 300 miles northeast of Mumbwa; less complete ones from Ufipa (307), from the BaKaonde of the Kasempa district (184), and from the BaIla who range into the Mumbwa district itself (242).

Ushi smelting claims special interest since it employs a high, permanent furnace without bellows for the first reduction, and a smaller temporary oven in which the iron is further refined under a hand-forced draught. This suggests a connection with the technique of copper-smelting among the BaSanga and other tribes of Katanga, the neighbors of the BaUshi on the west. The Ushi furnace resembles those of Katanga not only in size — it is seven feet high — but in the use of ant-hill clay as a material and in the propping of the walls from the outside by poles. It is built on a slope of ground with its main entrance, large enough to admit a crawling man, placed on the down-hill side. Opposite this door is a smaller one, with several minor openings spaced between the two.

The BaUshi take extreme care in making the clay ventilating pipes, entrusting this delicate task only to expert smelters. Having mixed and beaten the clay with long pestles, they mould each pipe on a smooth pole which has been lubricated with white wood-ash, now and then smearing the growing clay with a certain red tuber which has been crushed in hot water, apparently to strengthen it and to give the burnt pipe a glaze. The finished pipe — two feet long, two inches in diameter at the big end and tapering to one and one-third inches at the smaller, with a wall averaging half an inch in thickness — is rolled in red millet chaff, covered with grass, and left to dry hard.

Firewood has now been gathered, charcoal prepared by loosely burning wood in an open fire, and the iron ore has been broken to walnut-size pieces by heating and quenching and cracking between large stones. The smelters fill the furnace with wood and charcoal — the latter occupying the interstices between the pieces of wood — pile the ore on top of this fuel packing, and cover it with charcoal. They then insert the ventilating tubes in the smaller openings at the bottom of the furnace and in the two doors, where they are held in place by the plastering which closes the doors during the smelting. Each tube projects about one inch on the outside, and each hole or door contains several tubes.

Smelting takes from thirty-six to forty-eight hours. The bloom is then extracted through the large door, broken up, and carried to an ant-hill to be further reduced and freed from dross.

The refining furnace, as I have said, is a temporary structure, a new one being made for each basket of ore refined. It is built on the side of an ant-hill, under a stout shelter of leafy boughs which keeps the draught from the flames. It is much smaller than the smelting-furnace, and is furnished on the upper side with a pair of bag bellows which communicate with its interior by means of two long clay nozzles, one from each bag, which lead into a single clay tuyere inserted in the furnace. The nozzles are tied to a firm stake and held in place by a heavy stone which is tied to the stake and bears heavily down upon them.

A wood fire is kindled at the bottom of the furnace with safety matches, and fed at once with a heavy load of charcoal. The iron, broken into small bits, is added little by little at the center of the fire, surrounded and covered with charcoal. From time to time, water containing a charm is sprinkled in. When the fire and charge have sunk to about half the depth of the furnace, the fire is lightly quenched with water, the walls broken down, and the rough, conical, white-hot lump of iron levered out with a stick.

Negroes on the plateaux of Ufipa (307) smelt and refine their iron in ways very similar to those of the BaUshi. From May to November the master smelters, with professional assistants, hunters, and such other men, women, and children as are ceremonially pure and wish to share in the work, live in small villages specially built near the mines. Near these they build their furnaces: truncated cones of finely ground clay, from two to three metres high and a little less in diameter at the base. Though inner support may be unnecessary if the clay is very good, the furnace is usually built around a frame of poles and twisted withes, with a similar frame on the outside to prevent splitting. The walls, thirty to forty centimetres thick at the base and fifteen centimetres at the top, are pierced at the bottom with about ten openings: two large ones opposite each other, the "mother" and the "father," for the extraction of slag, ashes, and iron; and a number of smaller ones, the "children," to accommodate the tuyeres. Men build the frames and the wooden binding of the furnace, dig the pit at the bottom for the medicines, and generally supervise the work, while women pound and mix the clay and build up the walls. To the boys falls the making of the clay tuyeres, which they mould around smooth poles resting horizontally on forked sticks set in the ground — a slightly shameful task, to be done in private, since clay is really a woman's material. The boys cut the long clay tubes into convenient short pieces and dry them in the sun.

Men mine the ore, women and children carry it in baskets to the furnace. Only the master smelter does the actual charging. Having climbed into the furnace he places two or three tuyeres in each aperture — including the "mother" and the "father" — and calls for the requisite materials to be handed down to him through the chimney. He first puts down a thick layer of charcoal, then one of ore, then one of wood somewhat thicker than either of the preceding; then

charcoal, ore, and charcoal again, which brings the charge to the top.

At nightfall the furnace is lighted. The smelters always do this from the top, since they do not want the furnace to burn so fiercely that the ore and iron are melted. Standing on a nearby ant-hill from which he can observe the fire, the master smelter directs the working of the bellows throughout the night, ordering the boys to apply the bellows to the fire where draught is most needed, and to cease blowing when the fire threatens to become too hot. Smelting apparently lasts throughout the night. The furnace is left several days to cool and the smelters then rake the waste material and the lumps of slaggy iron out through the large openings.

We are not informed how many smeltings can be done in a single furnace. A number are performed in succession at the same camp, however, so that the different groups participating — hunters, professional assistants, young people, and so on — can each have their share of iron.

The Fipa refining process resembles that of the BaUshi only in that the lumps of crude iron are surrounded with charcoal. Otherwise it seems almost unique; for it is done in a clay pot of a depth and internal diameter of about thirty-five centimetres, with an aperture at the bottom for the drainage of the slag, and three holes in the sides for the bellows tuyeres. In the center of this pot the smelter places the crude iron, which he encloses completely in charcoal; then, since he desires intense heat, he lights the charcoal from beneath and puts the bellows to work. At intervals throughout the process he pricks the softening iron with a cold iron rod to test its consistency, and pokes the lower opening in the pot to facilitate the drainage of the slag. The refined lump of iron is enough for about two hoes.

Iron-smelting methods of the BaKaonde in the Kasempa district of Northern Rhodesia seem to show some traits in common with those of the BaUshi and with the Katanga process of copper-smelting. Though Melland (184) unfortunately does not give the dimensions of their furnace, he says that it is plain and conical and made of clay, and that the bark nozzle of the bellows passes through a small ant-hill into the furnace. The bellows are apparently of the bag type. Melland explicitly states that the BaKaonde add lime to the charcoal for smelting copper but not for smelting iron, which leads us to suspect that the use of a flux by the Katanga copper workers may have been overlooked.

Smith and Dale (242)[6] describe smelting among the Ila-speaking BaMbala in the hills around Shanaobi, Northern Rhodesia, implying that the process is the same for all of the Balla who work iron. These smelters camp and build their furnaces near an ant-hill which yields good strong clay for moulding. They usually set four furnaces in a row, over four shallow pits, each one forming a truncated cone about five feet high and six feet in circumference near the bottom. The walls, about four inches thick, are built up of rolls of puddled ant-hill clay. They are topped with a well-defined lip which rests on sections of old clay ventilating tubes laid horizontally with their ends jutting over, and which is supported by a number of poles planted in the ground. A pole at the front of the furnace, fixed to a projection in the wall, gives additional support.

The smelters mould their ventilating tubes of ant-hill clay — carefully prepared by women — on smooth rollers about five feet long and as thick as an arm, lubricated with the slimy sap of the shikantyo plant; and rub the newly moulded clay in chaff to dry it and make it firm. The resulting tubes of clay are then luted into four openings at the four cardinal points near the base of the furnace: four tubes on the west side in the aperture through which the iron will be extracted; two on the east side, and one on the north and the south. These tubes slope downward into the furnace, but those from opposite sides do not meet.

The furnace is charged with alternate layers of charcoal and broken ore, built up over a fire already lighted at the bottom, and capped by more burning charcoal at the top. Smelting usually begins in the morning and lasts till late afternoon. The ventilating tubes are then removed, the debris pushed and raked out, and the bloom, having been extracted through the large western opening, is hacked free of slag and plunged into water. Smiths may now reform the iron into ingots of suitable size for the workshop and the market.

Small Furnaces and Hearths

Now let us return to the north and observe iron-smelting in the hearths and smaller furnaces, which are more widely distributed than the tall ones I have just described and which cannot be expected to conserve sufficient heat to produce cast iron.

The Ababua (111)[7] smelt iron on the slope of a termite hill, under a leaf-covered shed about six metres long and as high as a man. They have excavated the floor level down for about sixty centimetres long and forty centimetres deep. After mixing the ore — haematite or limonite — with powdered charcoal and thoroughly drying it, they lay it in the trench, making a bed about four centimetres thick, fifteen centimetres wide, and seventy long, and cover it with legongo leaf. On this bed they place the tuyere,

6. 242: pp. 202-21.

7. 111: pp. 233 ff.

made of sun-dried clay from a termite hill, and add more charcoal. When they have engaged the larger end of the tuyere with a four-chambered drum bellows, they light the fire; and as the smelting proceeds, pull the tuyere gradually toward the end of the trench. The process takes about four hours.

The Aoumbo (73), three days south of Franceville on the Upper Ogowe, smelt in a pit one metre square and one metre deep with vertical walls and a flat bottom. They fill this with alternate layers of charcoal and ore, and embed in the charge a set of clay tubes two metres long and seven or eight centimetres in diameter; either covering the charge with a thin layer of earth or leaving it exposed. They add no ore or charcoal during the smelting. The bloom is very heavy, spongy, and mixed with slag, which must be removed by reheating and hammering. The ore has been analyzed as: silica 22.10%, manganese oxide 8.28%, iron peroxide 69.12%, water etc., 0.50%.

The Labwor of the Karamoja group in Uganda (296) use a form of furnace unique in our records. It is a solid dome-shaped mass of clay, four feet high and between five and six in diameter, grooved at the top with a channel a foot wide and eighteen inches deep, which runs about three-fourths of the way across the dome and is open at one end. This open end accommodates the tuyere mouth, with a slab of stone wedged beneath it to prevent the escape of any molten metal. The tuyere is composite, consisting of a series of trumpet-shaped clay tubes fitted into each other, supported by Y-shaped sticks, and terminating at the lower end in a pair of clay drum bellows fashioned in a single piece and adjusted on a small pile of earth. The smelting-hut has a tall conical roof, and eaves which descend nearly to meet a low ridge of earth surrounding the floor. There is no door, no upright wall, and instead of the roof being supported by a central post it is supported by four arranged in a square. These are set in a solid mass of clay which may be used as a table.

The smelters first line the furnace with bundles of dry grass, held clear of the tuyere mouth by a series of small stones. On top of this tinder they pour charcoal, light the grass from a wooden fire-drill, and feed the fire with more charcoal as the grass burns away. Then, at five-minute intervals, they sprinkle into the fire limonite ground to pieces the size of pease and mixed with charcoal. One day's smelting requires about twenty-four pounds of charcoal and yields ten pounds of impure iron in three large lumps. These are refined by hammering and by repeated heating to bright redness in an open hearth, blown by a pair of drum bellows, a process which probably frees the mass of much of its carbon, though forcing some of the carbon to form iron carbide and thus give a partial steely structure.

The Kikuyu furnace (227), standing under a circular roof without walls, is an oval pit with tempered clay which, on the long sides of the oval, rises above the ground as a thick, everted lip, leaving at each end an open channel for a tuyere. The interior has the form of a blunt cone pointing downward and laterally flattened. At each end a pair of bag bellows, somewhat larger than those used in the forge, blow down a gentle slope into the furnace cavity. The smelters maintain an even blast from dawn to sundown, and leave the bloom cooling in the furnace over night. The next morning they uncover it, squirt water on it, pull it out with a banana-leaf-midrib rope, and pound it to pieces with round stones. The little lumps of crude iron which they pick out of it are heated in a forge and beaten into two-pound pieces for trade. Ten quarts of the granular ore produce six of these pieces. They are "a very pure form of steel; welded without difficulty simply by heating and hammering."

The furnace used by the smelters at Ondulu, Angola (217), is unique among our data. It is a long horizontal series of sections arranged on a gentle slope of ground, each section composed of two large, flat slabs of ant-hill earth inclining inward toward each other and held apart by small sticks. As each section is added, it is lined with a wall of mixed ore and charcoal; and when ten sections have been constructed and lined — forming a little gallery from ten to fourteen feet long — the long central space is filled with charcoal, pieces of ant-hill laid over the top, and the sides plastered with mud. Instead of placing their drum bellows at the ends of the furnace, as we might expect, the smelters place them at the sides, and work the sections one by one, removing the bloom and moving the bellows on to the next section as soon as each section has been smelted. It takes about one day to smelt a kiln of ten sections.

For Africa south of the Zambezi and Kunene Rivers — South Africa in the restricted sense of the phrase — our data on smelting leave us in the lurch. Holden (122)[8] has the Kafir furnace of sandstone, with the charcoal under the ore in the furnace and mixed with it; and claims that the iron flows out into pipes or moulds. Klemm (140),[9] on the other hand, says that the Kafirs smelt iron in a small round mound, with two vents for two pairs of goatskin bellows. Shooter (241)[10] describes Kafir smelting in a pit. Beck (23) credits the Zimpy (Zulu-Kafir) with a more elaborate set-up; three pits in a row, each oval, six feet by three in diameter and three feet deep. The ore, he says, is mixed with charcoal and smelted over a packed bed of the same fuel, with a pair of bellows working at each end of the pit. Some of this variety of description probably depends on the unspecific meaning of the term Kafir, geographically and culturally, and on the different periods at which the observations were made.

8. 122: pp. 167, 169.

9. 140: Vol. 3, p. 271.

10. 241: pp. 355–57.

Fülleborn (97, 98) diagrams but does not describe two Angoni smelting furnaces in Nyasaland, each apparently two or three feet tall and of truncated conical shape; but the use of drum bellows suggests that the Angoni have here taken over some of the more northern culture.

Furnaces and smelting processes not fully described in the ethnographies I have examined can best be represented in tabular form. I have arranged them generally from west to east, and from north to south.

Comparative Table

Tribe or place	Furnace	Bellows	Charge	Time, etc.
Western Sudan (Kooranko, etc) (151: p. 66)	Two large, bottle-shaped furnaces side by side, connected so that the same draught ventilates both			
Bambara (Kooranko) (293)	Cylindrical, sometimes funnel-shaped: 3.5-4.0 m. high			
Mandingo (Kamalia) (200: p.224)	Cylindrical, 10 ft. high, 3 ft. diameter: banded in two places to prevent splitting: pit below ground	Probably no bellows except to start fire; 1 pair, bag. 7 clay ventilating tubes at ground level	2. Alternate layers of charcoal and ore 1. Wood	48 hours
Mandingo (Fouta Djallon) (79)	Inverted bell form: door "for filling;" smaller opening for liquid metal (or slag?)	None; ventilating tubes		
Moors (Senegambia) (31: pp.118-19)	"Grands canaris de Fouta"	Bellows		Molten iron flows out into moulds?
Koranko (Sierra Leone) (78a)	Pear shaped, 6 ft. above ground, 5 1/2 ft. diameter at ground level: clay: roof a well-rounded dome, with aperture 8 inches in diameter: channel to drain off slag into hole outside furnace	Fire started by bellows. 8 sets of ventilating pipes, 4 in each set, incline steeply downward to near floor of furnace, come out about 1 ft. from surface of ground; made of mixed clay and grass fibres moulded around smooth sticks	Furnace fed alternately with baskets of ore and charcoal about walnut size till three-quarters full	2 or 3 days. Yield, 70 lbs. of iron. Lumps containing too much slag resmelted in smaller furnace
Liberia (133: Vol.1, p. 518)	Hills of <u>Termes bellicosus</u> used as furnaces			
Fouta (84)	Clay, 2.50 m. high, over pit 1.25 m. deep and 1.50 m. in diameter, "pierced at the top by a broad chimney:" bloom	None: 19 ventilating tubes of bamboo, with clay nozzles, at different	2. Alternate layers of charcoal and laterite	3 days. Iron refined in a second furnace

Comparative Table (cont'd)

Tribe or place	Furnace	Bellows	Charge	Time, etc.
	collects in a "special cavity"	levels, slanting downward inside, protruding 35 cm. outside	1. Lighted charcoal	with bellows
Foulse and Samo (Yatenga) (264:pp.218-19)	4-5 m. high, narrow: in bush near village		Laterite	
Kaarta (213:pp.272-73)	Large: not demolished: some wrapped with creepers to prevent cracking	None; clay ventilating tubes at ground level, withdrawn as fire gains force		
Habbe (Plateau of Haroua) (78: plate 55)	Clay; 6-8 ft. high: broad, bottle-shaped	6-8 openings at base		
Torobe (Gourma) (14:Vol.3, p. 188)	6 ft. high, 1½ ft. diameter at base: 3 channels and basin at bottom to receive iron		2. "Wood ashes" 1. Ore	
Uyame (Central Province, Northern Nigeria (275)	Clay, conical: "hole sunk in it:" in a hut	Bag bellows	Alternate layers of ore and wood	
Angas (Northern Nigeria) (182:Vol. 1, pp. 149-51)	Usually a circular furnace: sometimes cover pile of ore and charcoal with a large pot which has a hole at top for air	With circular furnace: ventilating tubes at bottom. With pot: 1 or 2 pairs of drum bellows	Alternate layers of charcoal and ore	Smelt 12 hours: leave 12 hours to cool
Hausa (Kano) (267:pp.207-15)	"A large earthen vessel" set in a hole: 3 perforations, each for 1 pair of bellows	3 pairs		
Banyeri (Togo) (127)	Tall, cylindrical: ore taken out door at bottom: stubby pole ladder	Ventilating flues: probably no bellows		
Dagari (52)	Clay: high: boot-shaped; door in top of "foot" of the "boot"	1 pair: elevated on clay pedestals with long descending tuyeres		
Bobo (and Dagari) (228)	1.60 m. high; in a bench; broken at bottom to extract iron: 2 orifices for observation of color of flame	1 pair	Alternate layers of charcoal and ore	

Comparative Table (cont'd)

Tribe or place	Furnace	Bellows	Charge	Time, etc.
Lolobi (127)	Tall	Ventilating tubes; probably no bellows		
Jaunde (310)	Furnace of plantain stems, 1. m. high, rectangular, over shallow, clay-lined pit. Smelting hut with high, pointed roof: horizontal wooden screen over furnace to protect roof	4 pairs of drum bellows, 1 pair in each side of furnace	Furnace filled with charcoal: mass of mixed ore and charcoal in center	Several hours
Mangbetu (199:pp.265-71)	Clay, above ground	3-4 pairs of drum bellows	Mixture of ore and charcoal	
Mangbetu (Abarambo tribe at Amadi town) (62: Vol.5, plate 93)	Pit 50 cm. deep; clay lined: broad clay border above ground; tuyere in sloping open passage at one side. Gabled smelting hut without walls	2 pairs of drum bellows	Layers of ore and charcoal	
Mandja (100:pp. 225-32)	Clay: 160 cm. high over pit 80 cm. deep: internal diameter 20 cm.: (data on height ambiguous: is pit a part of the chamber, or for workers around the chamber?): trench to furnace door 1 m. deep: iron extracted through door	7 clay ventilating tubes, 80 cm. long, 4 cm. internal diameter. Drum bellows probably only for starting	2. Add mixed ore and charcoal (1:2), 2 kilograms of mixture every 5 minutes 1. Fill furnace with charcoal and fire for 2 hours with bellows	20 hours. 150 kg. of ore smelted
Darfur	Small pit	Drum bellows	Mixture of ore and charcoal	
"Jur" (Luo?) (61; 237: pp.206 ff.; 215)	Clay: 5 ft. high over a pit: hour-glass constriction: entrance below ground level, sealed with clay during smelting: iron and slag extracted through this	No bellows; 3-4 clay ventilating flues, stoked to keep free of slag	"Male" and "female" ore both necessary	22-40 hours
Bongo (237:pp.208, 277 ff.;238)	Clay, 160 cm. high: 3 chambers one over the other formed by constrictions: central chamber separated from lower by a frame resting on a projection: ore taken out through a hole at the bottom which is stopped with clay during smelting	Bellows blowing through 4 flues	3. Charcoal in upper chamber. 2. Alternate layers of charcoal and ore in middle chamber. 1. Lower chamber filled with charcoal	Iron refined in crucible and "cleaned" by hammering

Comparative Table (cont'd)

Tribe or place	Furnace	Bellows	Charge	Time, etc.
Mpororo (299)	Single chamber above and below ground? Lower and broader than Jur and Bongo furnaces	Many drum bellows		
White Nile (118)	Pit surmounted by "clay chimney"	Bellows		
Bahr Seraf tribes (164)		Either with or without bellows (perhaps according to kind of ore)		
Lugwari (181)		Several pairs of drum bellows, each placed in gourd-shaped depression in ground		8 hours: iron left 2 days to cool
Galla (Shoa) (202:p.236)	Pounded or burnt clay, 2 m. high; 2 openings at base, the large opening for feeding; demolished to extract bloom; built at mine	Rarely kindled with bag bellows: otherwise no bellows	Alternate layers of ore and charcoal	4-5 hours: spongy bloom beaten free of dirt and slag
BaHima (Ankole) (132)			Ore mixed with charcoal	
BaNyankole (225:pp.105-107)	Clay, 3 ft. high, over pit 3 ft. deep: hole in top 4-5 inches in diameter	Several pairs of drum bellows (probably 3)	4. Charcoal added 3. Ore, broken to walnut size pieces 2. Charcoal 1. Layers of dry grass and reeds	8 hours: bloom cools 6 days before removal from furnace. Iron resmelted if very dirty
BaKitara (225:pp.217-25)	Pit 2 ft. deep, 18 in. wide: lined with clay, covered with clay lid which is perforated for charging and as chimney; 4 tunnels into pit for tuyeres: pit demolished after smelting	4 pairs of drum bellows	2. Add mixture of ore and charcoal in equal proportions at intervals. 1. Alternate layers of charcoal and ore	24 hours
BaGanda (224:p.381 ff.)	Pit 2-4 ft. deep, clay rim: furnace of ant-hill pieces rising above it, interstices filled with clay		2. Furnace filled with alternate layers of ore and charcoal. 1. Pit filled with dry grass.	

Comparative Table (cont'd)

Tribe or place	Furnace	Bellows	Charge	Time, etc.
			Hard "male" ore (magnetite?) and soft "female" ore (haematite?) both necessary	
Tobur (Uganda) (257)	Clay, 1. m. high: interior 60 cm. broad and 30 cm. deep: sloping canal to drain off slag: in hut		2. Ore, pounded to pea size. 1. Charcoal	
Karagwe (144:p.34)	Heap of ore and charcoal		Ore mixed with charcoal	
WaNyoro and WaKonjo (260)	Shallow pit	2-4 pairs of bellows: tuyeres lead under pit	Ore broken and mixed with charcoal	
Wanekirumbo (250)	Clay; 4 ft. external height; internal 2 by 2 ft.	4 holes for ventilating flues at ground level		
Masai (132;185: pp.110-14)	Clay furnace		Handful of ore thrown into fire every 5 minutes alternating with 4 or 5 handfuls of charcoal	2 hours: bloom as big as hen's egg
WaNyamwezi (Central or Western) (256)	Pit with walls of termite-nest pieces rising above it: 4 openings at ground level for bellows: demolished after smelting	Probably 4 pairs of drum bellows	2. Alternate layers of charcoal and ore. 1. Charcoal fills pit, fired first	10-12 hours
WaNyamwezi (Northern) (34)	Termites' nests built up over pit			
WaKonogo (Southern WaNyamwezi) (256)	Clay: built up in stages as charged: 4 holes at bottom for bellows: demolished after smelting	Probably 2 pairs of bellows	2. Ore. 1. Charcoal, lighted	2 nights. Bellows rest during day
Bagweh (Unyamwezi) (104)	Pit: 2-3 miles from village	2 pairs of drum bellows		1 day: 12 lbs. of iron produced
Kwasere village (near Pakhundi, Eastern Congo) (46:p.236-38)	12 ft. square? Center of floor slopes down toward deep trough to receive molten metal	Drum bellows		
WaPare (261; 21: pp.232-33)	Pit: in rectangular hut	Drum bellows	2. Ore. 1. Charcoal	
WanItumba (261)	Pit			

Comparative Table (cont'd)

Tribe or place	Furnace	Bellows	Charge	Time, etc.
Ugweno (261)	Pit			
Usindja (221)	Crude hearth with 3 sides of termite nest clay	3-5 pairs of bellows	Mixture of ore and charcoal	
WaLongo (Ngoma village, Usindja) (260)	Hearth of 3 large lumps of loam, or a pit? Smelting huts in a row	3-5 pairs of drum bellows	Mixture of ore and charcoal	
WaKinga (97:pp.166 ff.)	Clay: 70 cm. high, internal diameter 40 cm. at top: in conical thatched shelter	3 pairs of drum bellows: tuyeres project 6 cm. inside furnace, connected to bellows by wooden tubes		
Nyasaland (251)	Stones "in form of a long drain:" 3 ft. long, 1 ft. high, chimney at one end: melted iron flows into hole at end	1 pair of bag bellows	Mixed ore and charcoal	1 day
Angoni (Nyasaland) (252)	Clay; 10 ft. high, bottle-shaped: propped with poles on outside; on slope for slag to run down (derived from Atumbuka form?)	No bellows; 8 clay ventilating pipes at base	2. Add mixture of ore and charcoal at intervals. 1. Fill with charcoal, light from top	48 hours
Angoni (Nyasaland) (97)	2-3 ft. tall; iron collects in circular trough at bottom; opening broken in wall	Drum bellows		
WaNyika (West of Nyasa Mts.) (97:pp.167-68)	2.5 m. tall; external diameter 2 m. at bottom, 1 m. at top; lasts 15 smeltings; access to top from a tree	5 pairs of flues	Ore decomposed gneiss. Grass mixed with ore? 4. Ore between wooden pieces. 3. Lined with wood 2. Charcoal. 1. Dry twigs	
Achewa (Dowa district, (Nyasaland Prot.) (120)	Pit with clay wall rising above it			
West of Lake Nyasa (161:pp.535-37)	Clay; 6 ft. high, 2½-3 ft. in diameter			
WaMakua (97: p.170)	Smelt in termite hill; sometimes in pit in side of a hill?			

Comparative Table (cont'd)

Tribe or place	Furnace	Bellows	Charge	Time, etc.
Garenganze (Katanga) (5;10:p.239)	Large trench covered with mud after charging; openings at both ends	"Little bellows" at each end		"Seven days"
BaKaonde (184:pp.136-37)	Clay, conical	Bag bellows		
BaIla (242)	5 ft. high; 6 ft. in circumference?			
BaLuba (58:pp.223-25)	Clay block; internal diameter 30 cm.;hole opposite door for tuyere	Drum bellows		
Congo and Angola (149)	Pit	Drum bellows	Charcoal	
Tschikunsa village,Angola (142)	Clay; 50 cm. high, broad, roughly cylindrical; door for lighting and extraction, blocked during smelting	Drum bellows; tuyere to special opening in furnace	Charged from top	
Ovimbundu (114:pp.158-61)	Clay, conical			
BuShongo (282)	Pit	Drum bellows	Alternate layers of charcoal and ore	48 hours
Sungu (South-central Ba-Tetela) (277)	Smelting in an open shed	Several pairs of drum bellows	Mixed ore and charcoal	Several days.Repeated heating to refine
Olemba (BaTetela) (277;283: p. 135)	Furnace circular	Bellows	3.Charcoal. 2.Wood. 1.Ore	1 day; 2 days to cool
Northern Ba-Tetela (277;283: pp.135-36)	Circular shaft sunk in large platform made by excavating half of the smelting-hut floor	Bellows; tuyere through hole at base of platform	2.Ore. 1.Charcoal to middle of pit	
BaRega (44:p.536)	Pit 1 m. deep; stone furnace raised 1 m. above pit			
Manyema (46:p.257-58)	Excavation 6 ft. by 20 ft.,4 ft. deep, with sloping floor;clay furnace,4 ft. wide,built across this at 6 ft. from the end of the excavation;smaller division of excavation gives access to furnace for stoking:iron and slag ex-	Drum bellows; 12 pairs sometimes used		

Comparative Table (cont'd)

Tribe or place	Furnace	Bellows	Charge	Time, etc.
	tracted in larger division. Smelting hut 20 ft. by 30 ft., low walls, high roof.			
BaHoloholo (233: pp. 117-18)	Pit			
BaSonge (198:pp.223 ff.; 283)	Funnel-shaped pit	Drum bellows: 1 pair?	Alternate layers of ore and burning charcoal	
BaMbala (Southern) (283)	Clay, rectangular smelting hut with oval conical roof	4 pairs of drum bellows, 1 pair at each corner of furnace	2.Charcoal. 1.Powdered ore	Ore flows through channel into reservoir at side of furnace
BaNgala ("Boloki") (298)	Pit, 18 by 12 inches	Drum bellows	Crucible full of ore;set in charcoal?	
"Kaffir" (122; 23: Vol.1,p.321)	Low mound or chamber	2 pairs of bag bellows	2.Ore and charcoal mixed. 1.Charcoal	
BaVenda (137;255: pp. 59-60)	2 methods: 1. built-up furnace. 2. in large clay pot in anthill	3 pairs of bag bellows	Crushed ore mixed with charcoal	Iron refined by second smelting
Ovambo (4)	Crucible			
"Southern Bantu" (300)				Iron refined in crucible
Hottentot (230:citing Kolb)	Small mound?		Fire over ore?	
MaShona (245;268)	Clay; truncated; 20 inches to 3 ft. high; modelled with female breasts; opening at top; broad, low door at bottom	2 pairs of bag bellows		Ore and charcoal added little by little for several hours;relatively little slag
Zulu (129)	"In a soft porous stone hollowed for the purpose"			

Furnaces

One point becomes immediately obvious from a glance at the foregoing descriptions: all of the hearths, small pits, and smallest furnaces require bellows, whereas many of the large furnaces do not. This is because the latter create their own draught, and allow the carbon monoxide in its passage upward to play a powerful part in heating and reduction.

Among the large furnaces, however, the length of time necessary to smelt the ore seems to bear no constant relation to the size of the furnace or to the number of bellows used. Some of the longest smeltings (Kamalia, 48 hours; Luo, 40 hours; Angoni of Nyasaland, 48 hours; BaUshi, 36-48 hours) are performed in large towers with a natural draught; but the BaSakata, with their tall oven blown with sixteen bellows chambers, and the BuShongo with their drum bellows and their simple pit, take as long a time. The shortest processes recorded are those of the Baya-Kala (5 1/2 hours) and the Ababua (4 hours), with three or four bellows chambers; but the former employ a furnace thirteen feet high and the latter a shallow trench.

Without taking the character of the ore into account — for this, unfortunately, is an unknown factor — the advantages gained by an increase in dimensions seem mainly these of quantity and permanency, the larger and more elaborate forms not having to be rebuilt for each smelting. But some of the smaller furnaces, and not all of the larger, are permanent. Those of Dande village, though three and one-half or four metres high, are built around the pile of charcoal and ore and are presumably demolished after every operation; while those of the Baya, though less than a metre high, can be used a number of times.

Our only indication that bellows may shorten the process comes from the Baya, where the Bogoto sub-tribe, using only a natural draught, take more than twenty-one hours, whereas the Baya-Kala and Southern Baya use three bellows chambers and take from five hours to nine. The use of bellows in smelting seems labor wasted; and it is hard to conceive of any Negroes practising it after they had once learned that they could obtain enough draught by building the furnace a little higher and inserting a few more ventilating tubes.

The account for Ufipa, however, where the master smelter stands by on an ant-heap to direct the bellows boys where they shall apply the bellows and how long they shall blow, according to his expert observation of the fire, suggests that the bellows may aid in regulating the draught rather than simply give it additional strength. The WaFipa, with their large furnaces — and possibly with their limestone and bone fluxes — have to be particularly careful not to produce cast iron.

The limited distribution of the natural draught technique is rather remarkable. We find it in the area west of the Niger's lower course; among the Bogoto of the northern Cameroon; on the Upper Ogowe; among the Luo on the Bahr el Ghazal; among the Galla and perhaps other groups in the Horn of Africa; occasionally among the Bahr Seraf tribes (perhaps according to the variety of ore smelted); and among the Nyasaland Angoni, WaNyika (?), WaNekirumbo (?), and BaUshi and BaIla between Lake Nyasa, Katanga, and the bend of the Kafue. This technique always implies a large furnace; and conversely, the tower-like furnaces of the Western Sudan were probably never used with bellows.

Neither were most of those in the Nyasa-Katanga-Kafue area; but in Ufipa, just north of Lake Nyasa, bellows regulate the draught into furnaces two or three metres high.

The antiquity of such large furnaces is unknown. On the road from Moliro to M'peveto in the Katanga, and especially on the little Kamussenga River, Lemaire found a number of abandoned smelting furnaces, three metres high and two metres in diameter at their base, about which the local natives — Bena Marangu, WaBemba, BaMambwe, KaFwanka, Kassi-Kissi, and the iron-working Sanduruka — knew absolutely nothing (193). Though the clay walls, baked by use, might not weather away very fast, these furnaces are probably not very old, for Lemaire says nothing of any signs of great antiquity.

I do not believe that the large Galla furnace, with its self-created draught, has any historical connection with the large blast furnaces of the Western Sudan or the Katanga-Nyasa region. It is too widely separated from them by other sizes and forms, and too near to Arabia, from which the metallurgy of the Horn of Africa has received a constant influence.

It is amusing to find the crudest smelting accommodations — bellows blowing into pits, shallow trenches, or superficial hearths formed of three blocks of earth — concentrated among the Northeastern Bantu, on the borders of the region from which Negro Africa is said to have first derived metal-working and the other refinements of life. This, however, is more apparent than real, since our notes report smelting in small pits throughout the Congo and Angola, though with very few specific references. Except among the Aoumbo on the Upper Ogowe, who use free ventilating tubes, and the Akikuyu, who use bag bellows, drum bellows seem to be invariably associated with these rudimentary types of furnace, and are probably, as we shall see, the original Negro African form. We are thus tempted to trace the iron smelting of the Northeastern Bantu back toward the Congo, especially since the Lakes tribes traditionally derive it from the west.

The distribution of small clay furnaces, less than three feet over all, seems scattered and without significance: Durru (Adamawa), Labwor, WaKinga, BaLuba, Tschikunsa

village (Angola), Ovimbundu, Mashona. The largest furnaces, however, are correlated with the natural draught process, and suggest much more in an historical way, since they occur in precisely those two, widely separated areas where recent trade in metals has been most intense: the Western Sudan, and the copper-bearing region between Katanga, Lake Nyasa, and the Kafue.

In the absence of any data on the relative difficulty of smelting the different kinds of ores, the above observations seem to prove very little. Nevertheless, they lead us to evaluate the size of the furnace and the use of bellows not as improvements which, once invented, would tend to spread and perpetuate themselves on their own mechanical merits, but as parts of the broader industrial patterns of the groups in question.

In the present state of our knowledge, the distribution of furnace forms seem quite haphazard, some tribes having exercised a great deal of ingenuity in this respect, others having kept their furnaces on very simple lines. Several points, however, suggest interesting technological and diffusional trends.

Some tribes apparently attempt to separate the molten iron from the charcoal, probably to prevent it from taking on more carbon and becoming too brittle. The Ababua do this by a heavy layer of green leaves between the lower bed, composed of layers of charcoal and ore, and the upper bed which consists entirely of charcoal and on which the tuyeres rest. The horizontal partition in the furnace at Dande village, in the Western Sudan, may serve the same purpose. The constricted furnaces of the Jur and Bongo, having two and three chambers respectively, suggest the same idea; but the Jur furnace could not work in this way, since the ore has to drip down through too much burning charcoal and receives no protection against carbonic gases. The Bongo furnace partitions only partially separate fuel from smelted iron, the upper and lower chambers being filled with charcoal, while the middle chamber contains both charcoal and ore. These partitions may serve to prevent excessive oxidation by narrowing access to the air.

The termite-nest walls of the Nyamwezi iron-smelting furnaces indicate a connection with the Katanga, where furnaces for smelting copper are made of the same material; and remind us of the copper trade from Katanga through Unyamwezi, as well as the westward migration of the BaYeke into Katanga, and the similarity of coiled wire bracelets in the two areas. We must remember, however, that throughout tropical Africa the finely equalized clay from ant-heaps is probably the best available material for furnace walls, its uniformity giving considerable resistance against cracking.

The use of green wood for the furnace walls by the Pangwe and Jaunde falls into line with their whole material culture, in which wood and bark containers far predominate over clay.

The pot used for smelting by the Angas and by the Hausa of Kano seems a strange makeshift to occur so near the large furnaces of the Western Sudan, and its distribution should be studied in greater detail. It may be a degenerate feature due to extensive trade, where the importation of metals surpasses their production.

The gynecomorphic furnace of the Mashona harks back to that of the Alunda — which modesty prevented the ethnographer from describing — and is one of a series of Southern Congo traits which the Mashona display.

Cast Iron, Wrought Iron, and Steel

While writing of Mumbwa and the principles of iron-smelting, I have pointed out the relative virtues of cast and wrought iron, and have mentioned the rarity of the former in Negro Africa. Smelting pits and hearths, such as those of the Congo and most of East Africa, can probably not heat the iron enough to melt it to a liquid state in which it could absorb much carbon. As for the smelting <u>furnaces</u>, however, especially such tall ones as those of west Africa and the BaUshi, it seems quite obvious that the production of steel or wrought iron was voluntary, and the production of cast iron a blunder. This is attested by the care with which the Basari smelters regulate the draught in their furnace, and consequently the temperature, by opening and closing the ventilating holes; and by the master smelter in Ufipa, who directs the bellows throughout the process, lest the furnace be overheated. On the same point, Stanley (245, 246) reports from German Southwest Africa one specimen of white cast iron "apparently produced by overheating," and pertinently remarks that the large furnaces of West Africa might have been regularly capable of this, while the simple smelting pits of South Africa were probably not. Negro smelters seem usually to have aimed at what Gaud (100) describes for the Mandja, "a soft steel not susceptible of tempering but endowed with a certain hardness ... which allows the manufacture of sharp blades," a product which, in this particular case, analyzes: Fe 97.5%, C 0.2%, Mn 0.1%, P 0.2%, Si 1.8%, S 0.01%. Their lack of skill shows itself not in the quality of their iron but in the great amount lost in the slag; the Mandja, for example, losing 12%.

When we polish a section of native iron, lightly etch it with acid, and examine it under a low-power microscope or even with the naked eye, we see that it has a very non-uniform consistency (245). The slag entangled with it will appear almost everywhere as dark swirls, ripples, and blotches on the bright background of the pure wrought iron. Often, however, the surface is marked with several intermediate shades. These represent iron carbide; and a sufficient proportion of

this compound to make the material harden at sudden cooling will bring it within the category of steel.

If we separate and chemically analyze these areas of differing darkness we find that their carbon content ranges all the way from zero in the pure iron to 0.9% in the iron carbide. Combined carbon, as we have seen, reduces the melting point of iron, and it may be that owing to a high proportion of charcoal in the furnace charge, and long heating, some parts of the bloom become sufficiently carburized to melt during the smelting. But Stanley believes that the heterogeneous structure observed in the iron of native tools is due not so much to partial melting as to reheating and repeated hammering at the forge. While this reworking eliminates much of the charcoal and slag enmeshed in the original bloom, it also carburizes the iron and forms irregular areas of steel. Stanley (245) has observed this partial steel structure in iron made by the BaKgatla and Mashona, in implements from the old mines of Rhodesia, from Zimbabwe, and from the Renders Ruins. A small piece from under the Conical Tower at Zimbabwe showed low carbon and medium carbon steel separated by a line of slag inclusions; a small rod from the bottom layer of a midden deposit at the same site, sixteen feet below the present surface and, according to Caton-Thompson, contemporaneous with the earliest inhabitants, showed steely iron mixed with slag; an assegai blade from the same location was half iron, half mild steel, the two elements again being separated by a line of slag; another, from beneath the intact "cement" floor of the Maund Ruins analyzed medium carbon steel in the center, low carbon metal surrounding it, with slag inclusions; while an arrowhead from the Renders Ruins, though composed mainly of carbon free iron, showed an area of steel separated from the iron by a line of slag. Apparently none of these pieces had been made from previously melted metal.

Stanley does not deny the possibility of melting iron in the native furnaces, but claims that such an action would be rare, and, as in the case of the piece of "white" iron from Southwest Africa, would produce a layered mass of fused and pasty metal which could not be forged and would be thrown away as useless.

In a few instances, however, the iron seems to have been liquified in smelting, and then "puddled" by repeated heating and hammering to reduce the excess carbon which it has assumed in a liquid condition.

Barth (14)[11] in the middle of the nineteenth century wrote that at Torobe in Gurma the smelted iron ran out of the furnace through three channels into a basin. Spiefs (244) says that in the Evhe smelting, in Togo, "the iron remains on the fire till it melts and runs into holes which have been dug." Durand (84) reports that at Fouta in French West Africa the iron flows from the smelting furnace through a channel into a hole made to receive it. The Koranko tribe in Sierra Leone smelt their iron to a more or less molten state. This "white cast iron" is then decarburized by puddling (78a). Berenger-Feraud (31)[12] for the Moors of Senegambia, and Delafosse (71) for the Senufo, say that the molten iron runs from the furnace into clay moulds. Delafosse describes the bar of metal in the mould as impure, spongy, and full of scoriae; and Berenger-Feraud says that the iron so base has to be forged and beaten to make it tough — presumably the puddling method. These two latter accounts, however, sound very doubtful, since the authors may have mistaken the ventilating tubes for moulds.

In the Congo, Torday and Joyce (283) claim that the BaMbala make the iron flow out through an opening in the furnace wall. But in the far south, Schapera (230) doubts Kolb's description of Hottentot smelting, in which the iron is said to have run down a channel into a basin at the side of the furnace.

Stannus (251) claims that among the Nyasaland Angoni it collects in a circular trough at the bottom of the smelting furnace, which it could hardly do unless fairly molten. For other Nyasaland groups the same author states that the iron is so fluid that it flows into a hole made to receive it at one end of the furnace; and he adds that this crude iron "is then again melted in a hole in the ground with a charcoal fire about it, and then the metal run into a long trench to form a thin bar which is hammered into a spear."

At the first reading, this account sounds like a makeshift of hearsay and imagination from one who knows nothing about iron metallurgy and has never seen Negro smelters at work. Iron which could be "run into a long trench to form a thin bar" would seem to become too brittle on cooling to be "hammered into a spear." But Stannus is partially corroborated by other observers nearby. Holden (122) says that from the sandstone furnace of the Kafirs the molten metal flowed into moulds or pipes, though it became more malleable than modern Swedish iron. Stayt describes the Venda practice in similar terms (255): "The iron implements were made by allowing the molten metal to run into rough clay casts, being afterwards hammered into the required shape." These accounts are either fallacious or defective; I think they are defective. They give us no analysis of the iron, and neglect to state how molten it is; and the final forging is probably preceded by repeated heating and hammering to drive off the ex-

11. 14: Vol. 3, p. 188.

12. 31: pp. 118-19.

cess carbon. The accounts are explicable only by allowing this long puddling process; which, Mr. Yatsevitch informs me, must be performed in the presence of iron oxide scale. They are somewhat substantiated by the ancient production of cast iron at Mumbwa, not far to the northwest.

Ornamental castings in iron are another matter, for in every observed case they are made by remelting the iron after it has been smelted and cooled. Though they will be more fully discussed when we come to casting, they have some bearing on the question of the temperatures obtainable under primitive conditions. Beech (24) mentions moulds when discussing iron working among the Suk; Meek (182) has reported cast iron from the Hausa; and Himmelheber tells me that the Baoulé sometimes cast iron by cire perdue, though the results are crude and unpleasing. In all of these cases the metal must have been smelted in a crucible. It would be interesting to know whether the "figures of men and beasts" in the Butchers' Hall at Antwerp, and credited to King Miele of the Bushongo, who lived in the sixteenth century, are of wrought or cast iron (279).

V. OLD WORKINGS FOR COPPER AND TIN IN SOUTHEAST AFRICA

THE SOUTHEASTERN AREA

Mumbwa is only one of the mysteries in an area alive with them. The Transvaal, Rhodesia, and the Katanga region form a distinct metallurgical province, characterized by the mining of copper, tin, and gold, the size and complexity of the mines, the use of smelting-fluxes, and the making of bronze. Since the early copper and tin mines in this area seem to lie on the same historical horizon, they should be considered together rather than with mines for the same metals respectively elsewhere on the continent. The area includes two well-marked nuclei: in the north Katanga, where the natives worked copper on a large scale into recent times but never exploited the local sources of tin (294); in the south the Transvaal, with its anonymous old mines for both of these metals. Though some native copper has been found in streambeds in the southeast (95),[1] it occurs but rarely, and is dwarfed into insignificance by the quantities of ore extracted from the mines. Gold, found mainly north of the Limpopo, plays a greater part as a lure for foreigners than as a material for Negro industry, and has already been considered with its history elsewhere in Africa.

A MODERN EXAMPLE

A glance at modern Negro work may give us a picture of similar activity in the past. Copper mining and smelting still survive among the natives of Katanga, on the border of Northern Rhodesia and the Belgian Congo (116,150,219,294). The Katanga copper belt is about 225 miles long and between thirty and sixty miles wide (294). BaSanga and BaYeke were the leading miners in the district between the Lufira and the Lualaba, but elsewhere in Katanga various groups came to participate. The "Star of Congo" fields, sixty miles east of the Lufira, were exploited by the BaTemba, the Bena Kasaka, and probably the BaSeba of Kaponda; while the Bena Boa of chiefs Katanga, Tenke, and Poyo worked the mines at Shituru and at Luishia, just east of the Lufira, meeting at the latter place the Bena Ngurube miners from Kaniamina. Poyo's people, more than thirty miles from their home, mined copper at Likasi and Kambove, west of the Lufira near the headwaters of the Dikuluwe, where they met the Bena Nsofu miners of chief Ponda (150). Though the individual shafts and galleries were private property, neither tribes nor persons seem to have had exclusive rights over any of the copper fields, as they did over hunting and fishing territories, and we hear of no fights about the mines (150). The proximity of an enemy, however, may have prevented access; as in the case of the BaYeke, who, because of their war with the Bena Boa, kept away from the eastern mines and worked those between the Lufira and the Lualaba, where they had established relations with the BaSanga. Though living at rich copper sources, the Bena Kaonde, BaLebi of Movia, and the people of Mobambi, never exploited them. The Mobambi specialization in iron working may have prevented them from giving their attention to the other metal.

BaYeke mining (116) begins after the sorghum harvest in April or May and lasts for the whole of the dry season. The people set up a temporary camp by a stream near the mines, where those who are not qualified to engage in mining can plant and cultivate small fields of eleusine, assisted by the miners in their spare time. Women and children quarry malachite from the surface of the ground. The men dig the large pits and shafts, passing bark buckets full of ore from hand to hand up the wall, and sometimes building fires to break the harder rocks. Arnot (10)[2] says that the copper miners of this region ("Garenganze," between the Lufira and "Lukuruwe" Rivers) seldom dig their shafts deeper than twenty feet and have no lateral workings. Rickard (219) and de Hemptinne (116) give a depth of forty or fifty feet as the usual limit, with sixty feet as the maximum length of underground passages. De Hemptinne, however, claims that the BaYeke usually take out about one metre a day, and may dig down ultimately as deep as 115 feet, using wooden supports for the shaft, though they never carry their side galleries very far. Apparently they do not understand the smelting of copper silicates and sulphides, and whether they smelt copper oxides remains doubtful. Men divide among themselves the ore obtained from the larger workings, while women take whatever they themselves have mined on the surface. The chief receives a stated proportion of everyone's ore or of all smelted copper.

In 1920 at Musonoi, 150 miles west of Panda in Katanga, T. S. Carnahan (219) found copper being mined by gangs of Negro women under male bosses, one boss to every fifteen women. These Negroes were of a "much better physique" than the local people and appeared to have come from Angola. They mined soft ore from veins and seams in siliceous dolomite, by digging irregular, inclined holes following the richer beds, sometimes to a depth of thirty or forty feet.

1. 95: pp. 70-72.

2. 10: p. 238.

Working without lamps or ladders, they passed the ore up in baskets to women on the surface, who sorted it and panned it at a nearby stream. They then took it to a village three miles away to smelt it and cast it into cruciform ingots.

The oldest living natives in the Katanga have no recollection of operations at the mines of the eastern district, where holes ninety to one hundred twenty-five feet wide were dug to a depth of twenty or twenty-five feet; though some of these veterans remember serving as porters on expeditions carrying Katanga copper to the shores of the western ocean (219).

ANCIENT MINES

Only archaeology and historical research may be expected to determine the antiquity of metal-working in the Southeast and the identity of the earliest mining promoters. These studies have so far failed to do so. The local archaeologists have preferred to examine and classify the crude stone implements which they knew must be very ancient, apparently unwilling to waste their talents on old mines and kraal- sites which they might have to date within the last few generations. We can only patch together the available observations in archaeology, history, and ethnography,and hope, in spite of their varying quality, that they will cover the leading parts of the story.

Unity of Type

One naturally asks how far we are justified in lumping the old mines together for single treatment. The Katanga workings should perhaps not be discussed along with those of the Transvaal. I have described them only as an example of what native miners may achieve. As we leave them and go southward through Rhodesia, however,we find that ancient mines have practically a continuous distribution. Though those of the Marico district, doubtfully reported, are probably recent Bantu work (284), most of the larger workings of the Transvaal undoubtedly belong together. They cluster especially in the Zoutpansberg, Waterberg, North Rustenburg and North Middelburg districts, and to a lesser extent in Lydenburg and Carolina (284). None appear south of the northern edge of the high veldt at about the latitude of Pretoria (284). Generally appearing superficially as depressions with a rich overgrowth of bushes (284), they reveal to closer examination a number of details in common. All have been deliberately refilled with the dump material; and since in two known instances this filling rested on a stull, it was probably done by the original workers themselves (284). The miners extracted all ore from the reefs for the full depth of the workings, and left very little in the dumps (284). As copper ore they preferred malachite (copper carbonate), perhaps because they did not understand how to smelt the silicates, sulphides, and oxides (294). Associated remains are limited to a few small smelting-sites, miners' tools and utensils, and a "graded road" near the Rooiberg tin mines, with here and there a human skeleton of modern aspect, and aid us little in dating the mines or identifying the leaders of the mining enterprise.

Copper Mines

Old copper mines occur as far west as the Tebedzi River on the border of the Kalahari (64,66). One of the Tebedzi mines is eight hundred feet long, and in places one hundred thirty feet deep, and must have yielded at least 1000 tons of copper (64). But this group may be considered as only a western outlier.

The greatest old workings occur in the Transvaal, are known in some detail, and show strong similarities with those farther north. Four extensive groups (286) lie hidden near Messina (247), in forests where the more lawless of the modern Negroes have sought refuge from the hut-tax and the district constabulary (53). Natives try to keep the whites from knowing about them, explaining that former chiefs ordered them refilled to discourage white prospectors (53). The Messina ores, assaying 50-60% copper,occur in granitic formations as veins of copper carbonate near the surface and as large lenses of copper sulphide further down. The miners extracted them by open casting in pits and trenches, following horizontally the course of the vein, never making drives or shafts (286). Though apparently they did not sort one kind of ore from the other, and sometimes worked the sulphide to a depth of eighty feet (286), they usually confined themselves to the carbonate nearer the surface, which was softer and more easily smelted.

Since most old mines are dry, their depth seems to have been limited by the changing character of the ore rather than by the presence of ground water (248). The largest single working at Messina attains a width of one hundred fifty feet and a depth of seventy. The miners gained access to the lower levels by means of wooden ladders (247) and toe-holes (53) in the wall. They sometimes attacked the hard face by fire-setting and sudden cooling with water, but usually hacked out the ore in a haphazard way with short iron gads driven by round basalt hammer-stones. To judge from marks left sixty-five feet down in the wall of one mine, some of these gads were square or angular in cross section (105). They may have been imported from the Spelonken district, where iron-smelting has flourished. All of the mines were intentionally refilled before abandonment (286), some of them as the work progressed. One hole eighty feet deep and fifty by thirty feet in horizontal dimensions must have yielded 1000 tons of copper (284). This whole Messina group seems to have produced about 5000 tons (286).

The Palabora area, including Lulu Kop and The Guide, may have yielded about 10,000

tons of the metal (286). Here we find vast fields of early copper-mines as pot-holes, open casts and reef workings (286), some of them forty or fifty feet deep (284). Most of them have never been reopened (284). On the flat along the east foot of Lulu Kop lie a series of workings in which the reef has been neatly stoped out (284). The ores at The Guide, sulphides disseminated in pyroxenite, may have yielded only 2% copper (286).

Near Wagon Drift at the foot of the Drakensberg, on the headwaters of the Koodo's River (286), the ancients worked bornite (a sulphide of copper and iron) in inclines, drives, and stopes. At one of these mines a lode dipping at an angle of twenty degrees was open-cast down to a vertical depth of thirty feet, from which a reef was worked out with drives and stopes for another one hundred feet on the incline, the total length worked out along the strike being about one hundred fifty yards (286). The mines at this site had apparently been dug with a definite plan, and had all been refilled (286). They may have produced more than 500 tons of metallic copper (286).

Copper mines occur north of the Transvaal where tin mines generally disappear. According to Dart (64), a "veritable ring of ancient copper mines has been discovered surrounding the Rhodesian gold bearing centre." On the Selkirk property (81), twenty miles southeast of Francistown in Southern Rhodesia, five outcrops of malachite have been mined to a depth varying from fifty to seventy feet, in working ten or twelve feet broad. In one a small shaft has been recently sunk and is timbered all the way down. These mines deserve special notice for the fragmentary ruins of a rough stone wall a few yards away, and an old iron working on another part of the same hill, with pieces of iron slag scattered around it. There is an extensive old mine on the "Alaska Property" of the Southern Rhodesian Base Metals Company, where the soft ore has been mined out and the hard ore left standing in pillars (294). Another group, only about fifteen feet deep but of vast extent, stretches all along the outcrop at the modern Kansanshi mine in BaKaonde territory, Northern Rhodesia (184,294).[3] Smith and Dale (242) note ancient copper workings near the King Edward Mine southwest of Lusaka. At the modern Bwana Mkubwa Mine, near the headquarters of the Kafue, the old miners extracted high grade copper carbonate along a vein in workings one hundred feet deep and twenty to thirty feet wide (66,49,69). In 1901 the prospectors of Tanganyika Concessions Ltd. located in the Katanga region more than one hundred fifty separate deposits of copper, most of which had already been worked. The largest of these old mines was a pit six hundred feet across and two hundred feet deep. It had no dump, and apparently all the ore removed from it had been taken to the bank of the Kafue, seven miles away, to be dressed and smelted (294). East of the Lufira lie a number of abandoned copper workings, 100-165 feet in diameter and 23-33 feet deep, heavily eroded and overgrown with large trees (116). Still further east, we find old copper mines in Macanga territory and at Pandamacua on the Zambezi (66).

Tin Mines

Though Dart (64) reports ancient tin mines as far north as Broken Hill in Northern Rhodesia, we find most of them south of the Limpopo. Several hundred lie in the neighborhood of Rooiberg, Weynek, and Leeuwport in the Waterberg district of the Transvaal, about forty miles west of the Pretoria-Pietersberg Railway (19). Here cassiterite occurs in well-defined lodes, pockets, pipes, and bedding-planes in the quartzite and sandstone of the Lower Waterberg series, associated with tourmaline, iron pyrite, and some pyrites of copper and arsenic (19). None appear in the granitic tin area around Zaaiplaats and Groenfontein (19).

The Waterberg miners preferred the non-lode ore bodies — pockets and other "supplementary fillings" — to the lodes proper, probably because the former yielded more tin; but they prospected thoroughly, drawing on all lodes of any importance, sorting the minerals carefully, and completely exhausting many of the deposits (19). When they reached the limits of a pocket, however, they apparently did not follow the line of fissuring in search of more (105). All stray pieces of ore show a high tin content. Since all the ore mined came from near the surface, it contained little or no sulphide (19).

Here, as in the copper mines, the miners sometimes broke the hard face by fire-setting (286), but hacked out most of the ore by means of unhafted hammer-stones and pointed iron gads, about eighteen inches long and of "dumb-bell" rather than angular cross-section (286,284). The gads, "equal in quality to the best Swedish iron," analyze: silica 0.175%, combined carbon 0.355%, sulpher 0.01%, and a trace of phosphorus, in addition to the iron (19,284). The hammer-stones are natural spheroids of weathered diabase, probably from a dike outcrop on the Onverwacht farm, and hard felsite from local dikes. They weigh between three and six pounds (19). No gads, hammerstones, or other artifacts have been found at the old Leeuwport workings.

Waterberg tin mines are seldom deeper than forty or fifty feet vertically (284), though the deepest working at Weynek ended at seventy feet vertical distance from the surface of the ground (286).

3. 184: p. 23; 294: Vol. 1, p. 17.

In the longest continuous one (19), on the South End lode at Rooiberg, the miners followed a lode horizontally for 620 feet, digging in places to a depth of twenty-seven feet. The cast narrows down from an average width of twenty feet at the top. The miners found the ore at the surface very payable, but failed to exploit a rich, narrow lode underneath. Baumann (19) gives a technical and somewhat bewildering description of an old mine at Weynek: "The tin occurs in soft clayey interbedded lodes digging 10 deg. west, and varying in thickness from a few inches up to 4 ft. The majority of the stopes do not go down more than 50 ft., but the principal one followed the lode to a depth of 120 ft. on the dip. The stope had been started as an open cast with a width of about 20 ft. along the strike, it then bellied out below to a maximum width of 50 ft., on the strike, coming down at the bottom to 15 ft. The average width of the stope was 30 in., but at places this narrowed down to 10 in. At that flat dip and narrow width no full-sized man could work, and the actual ore breaking must have been done by small boys or an under-sized race like the Bushmen." In this connection we note that two female Bushmen skeletons were found in one of the mines (286). Baumann continues: "This stope is of particular interest from the fact that a number of pillars were left in it, not as might have been supposed to support the hanging, but simply because the value had gone out of the ore. In addition to following the ore down from the surface by small shafts or open cases there is an instance at Weynek of a working having been entered by an adit at right angles to the strike of the hole." Pillars similar to those above mentioned were left in the reef workings at Weynek (286), where a reef at thirty degrees was mined down to two hundred feet and several hundred tons of tin extracted (284).

As in most ancient mines of the Transvaal, the Rooiberg tin mines have been deliberately refilled. We can hardly explain this laborious practice as an attempt to hide them from enemy prospectors, since in most cases the miners did not abandon a deposit until they had exhausted it (19). On the Empire lode at Rooiberg there was some partial filling in of stopes, using a roofing of wood and brush (19).

Large stone mullers and grinding stones suggest that the workers reduced the ore to powder before panning it at a stream to free it from the grosser impurities. This would leave a concentrate of perhaps 70% of tin (19).

Antiquity and Attribution

What is the age of these mines and who is responsible for them? Lest we yield to a popular bias in favor of great antiquity, let us caution ourselves with several arguments in the other direction. Schoch (234) sees no indication that they are older than 400 or 500 years. As internal evidence supporting this low dating, we have the preservation of hewn timber (19) in some of the workings, at Messina a sawed beam (105). The iron gads and hoes found in or near the mines show only a thin layer of rust (234, 294). Tree growth never represents more than two or three centuries (19), though a baobab six feet in diameter, and probably two hundred years old (247, 248), grew on one copper working at Messina. As external evidence we have historical record, which indicates that copper and tin were being exported from the interior to the southeastern coast at the time of the first Portuguese and Dutch explorers.

But the finding of relatively recent objects in the mines does not preclude antiquity, for they might have been worked over a very long period of time; and though Trevor's assumption (284) that the large workings are more ancient than the smaller ones seems quite arbitrary, we have to admit that several of the former show signs of age. The big mine on the South End lode at Rooiberg was refilled in two instalments, and had accumulated at one place two feet of surface sand over the bottom stratum of waste and rubble. This sand was striated in dark and light laminae showing that a "considerable number" of rainy seasons elapsed before the upper layers of rubble and surface sand were deposited (19). Some of the larger pits and trenches in the Katanga series had apparently been worked at three or more widely separated intervals, as indicated by soil accumulations and the growth of trees (294). Dart (67) points out a stalagmite fifteen feet high and eight feet thick at its thinnest point which obstructs the entrance to a cavern in a narrow belt of dolomitic limestone on Rookpoort Farm in the Rooiberg district (65). The cavern seems to have been worked very extensively in ways precisely similar to mining, but not a trace of any useful minerals has been found there. Dart suggests, however, that such minerals may be later discovered under the thick accumulation of bat dung which no one has taken the trouble to clear away. At any rate, the stalagmite stands "in such a position as to render practically certain its formation since the period of occupation by the miners." One drive in the "mine" is too narrow for a large adult to work, reminiscent of the same condition in the Rooiberg tin mines. The "Rooiberg cranium" from this cavern seems to have been deposited long after the "mining." None of the above evidence convinces us of an antiquity of more than three or four hundred years for the mines in general.

Clues to provenience are even more unsatisfactory than those to age. Some point to local Negroes. Nearly all of the associated objects closely resemble modern Bantu work (19), the sawed wooden beam in one of the Messina workings being a glaring exception. The absence of lamps, in parts of the mines where artificial light must have been necessary, again suggests Negro activity, since the modern Southern Bantu have no

lamps (19). The BaVenda, moreover, definitely state that their grandfathers worked the Transvaal copper mines (247, 248) and that their former chiefs ordered them refilled.

But both Dart (67) and Trevor (284, 285, 286) believe that a foreign group with superior cultural attainments supervised the mining. Seeking evidence to corroborate this, we find numerous clues, but nothing which definitely indicates any single foreign people. Rickard (219), who believes that no very ancient date should be given the Katanga mines, suggests that they were worked under the direction of the Arabs when the latter controlled the slave trade in central Africa. He cites several passages from Livingstone's Last Journals in support of this opinion. Livingstone knew an Arab trader from Zanzibar who dug Katanga malachite for three weeks, gaining 3500 pounds of copper. But Rickard's estimate hardly allows for the enormous size of the old workings, or for the references to copper in South and Central Africa before the time when, so far as we know, Arab slavers had penetrated far beyond the coast.

Though Arabs had reached Sofala at the beginning of the tenth century (146), had established trading stations in Portuguese East Africa before the sixteenth century (19) and penetrated as far up the Zambezi as Sena, they probably did not come south of Cape Correntes (284). Even as late as the fifteenth century the most southerly Arab settlement seems to have been at Inhambane, and Arabs probably never traded for metal in commercial quantities south of Sofala, nor undertook any large trading expedition south of that town after the Portuguese seized it in 1505 (284). Extensive trade contacts with the Indian Ocean, however, as well as trade in copper and bronze, may be postulated for Southeast Africa as early as the eighth century from the material found at Zimbabwe (50).[4] Idrisi, in the second half of the twelfth century, says that the islanders of Zahej or Zabej (Java?) were bringing iron from Sofala to India and Indonesia, and that the natives of Sofala preferred ornaments of copper (possibly brass) to those of gold, a preference likewise recorded for East Africans by Ibn el Wardi a few decades later (86, 19, 285).[5]

The BaVenda have a tradition that pale-faced men with head coverings directed the work in the local copper mines and took most of the output (247), a tradition confirmed by the BaPedi (284). Sekukuni's BaPedi, who lived between Lydenburg and Pietersburg, took the country from the BaRoka late in the eighteenth century. The head place of both these groups was the hill called D'sjate. In a traditional chant the BaPedi (285) relate that a party of bearded men called the Mapalacata, wearing clouds [sic] on their heads, came from east of the Drakensberg, occupied D'sjate, and were finally wiped out by the BaRoka — the tribe from whom, by the way, the BaSuto imported most of their metal (89). Though the BaPedi ascribe the ancient mines to these turbaned intruders, Trevor believes that the latter were probably only Arab raiders from Inhambane after 1500, and probably did little mining (284). It is said that they left some long-barreled rifles which were still in the hands of local Negroes within the last few generations.

Some flat, square bricks, quite different from those made by Europeans, are said to have been found near some extensive ancient mines at Mapathlela's Location and on the farm Naakdoorndraai No. 41, twenty miles to the south (285). Such vague reports, however, have almost no value. Nor can we give much weight to Dart's idea (66) that rock paintings in South Africa show "alien intruders wearing headgear of Babylonian and Phrygian appearance."

Trade objects that may have passed from hand to hand down the whole length of Africa during a number of generations or even of centuries help very little in attribution or dating, especially since such finds are sporadic and very poorly documented. Such, for example, is a gold coin "undoubtedly of Phoenician origin" and apparently "perfectly genuine," which is said to have been unearthed at a depth of fifteen feet in some recent excavations for the foundation of a monastery (285).

Old beads, however, have appeared in such variety and quantity that they may tell considerably more. About twenty-five years ago a kind which, according to Flinders Petrie, came into use in the Roman Empire in the fifth and sixth centuries was dug up in a native pot in the old workings at Messina (285). In 1916, Trevor (285) found several types in a rock cave at this locality: ivory beads with a partial spiral groove on the surface, small red and blue glass beads, and a facetted blue one most probably of European manufacture, together with ostrich-egg-shell discs of the common Bushman type. The ivory beads suggest BeChuana or Hottentot, while the glass ones may have been got by trade in the sixteenth century from the Dutch at the Cape. One Messina mine yielded blue glass beads "of a peculiar type" which showed very primitive annealing, and two large orbicular beads of combined quartz and limestone, apparently bow-drilled. Old blue glass beads have been found in the sand of a stream close to Himeville near Maritzburg; and one was unearthed twenty-five feet deep in gravel in the bank of the Tugela near Colenso (105). We should be grateful for an exact description of these specimens, particularly with relation to those found and dated at Zimbabwe.

4. 50: p. 188.

5. 86: Vol. 1, p. 66.

ANCIENT SMELTING

What became of all the tin and copper that were mined in the ancient Transvaal? We should expect the answer to help us with the question of mines. But again we are let down. Compared with the masses of metal which must have been extracted, the smelting sites so far discovered are almost negligible. Either they exist but have never been found, or most of the ore was exported. One or two nineteenth century references (161)[6] to malachite being traded eastward from Katanga suggest that it might have also been traded out of the Transvaal. On the other hand, Walker's remark (294) that the ore from the largest old copper mines in the Katanga was taken seven miles to the Kafue River to be washed and smelted would prompt us to look for smelting sites along streams within a few miles of the mines. But they still remain a mystery.

None at all have been discovered near the copper mines at Wagon Drift (286) or at Bwana Mkubwa (49). At Palabora we find some very small slag heaps at kopje bases, with foundations of forges, remains of clay tuyeres, and some hut rings, but they are probably late (234). The Messina smelting sites are also proportionately meagre, and may have been left by recent natives rather than by the ancient miners (286, 284). They lie on the hill-slopes where they are marked chiefly by small heaps of stony and glassy slag and broken tuyeres of mixed clay and quartz (246, 247, 248). The slags show a lime flux (246), probably provided by the snail- and mussel-shells found in and around the slag heaps (286), since the gneissic rocks of this country offer very little lime (284). Old Messina copper-smelting thus seems to have been superior to that of modern Katanga, where, as we shall see, apparently no basic flux is added to form with the acid silica a light, fusible slag, and where 40% of the copper in the ore is consequently lost.

Slag stained with copper oxide and containing beads of copper on the tuyere noses suggests that the copper was smelted in a hearth, and no crucibles have been found (247, 248). The slag heaps also yield pieces of copper sulphide, indicating that some of this more refractory ore found its way, at least accidentally, into the furnace. The slag, after beads of copper had been separated, analyzed (247): silica (SiO_2) 41.95%; alumina (Al_2O_3) 10.10%; ferrous oxide (FeO_2) 18.61%; lime (CaO) 21.08%; magnesia (MgO) 1.02%; cuprous oxide (Cu_2O) 2.58%; potash (K_2O) 1.20%; soda (Na_2O) 0.90%; sulphur (SO_2) 0.87%; water (combined) 0.56%.

The same scarcity of smelting sites characterizes the tin-fields. Some have turned up at Olievenbosch, and Weynek, and Haartebeestefontein (19), slag from small heaps on the western boundary of the latter farm analyzing 30%-50% oxide of tungsten and 2.5% metallic tin (19). This analysis indicates a great amount of wolframite with the ore; and the low percentage of tin in the slag seems quite remarkable, since wolframite is difficult to separate from the ore and reduces the fusability of the slag, in which most of the tin would thus be lost. The most significant smelting site, however, appears on a flat-topped hill called Smelting Kopje, on the farm Blaauwbank 433, about a mile and a half from the Rooiberg mine (19, 284). Here we find the circular clay bottoms of thirty or forty smelting furnaces (291), with stacks of hand-cobbed tin and copper ore, waste deposits of slag and fluxing materials, and stray samples of tin and bronze (67, 292).

Dart (66) and Trevor (284) say that no copper was mined in the Rooiberg district, and Dart states that the nearest important copper source is at Messina, two hundred miles away. The Blaauwbank smiths imported their copper ores as malachite in siliceous-ferruginous or siliceous-kaolinitic gangue, or in a matrix of serpentine, but never exploited the azurite, another cupric carbonate just as conspicuous and as easy to smelt, which they could have found close at hand (292). A sample of the ore showed 24.9% of the metal.

At this site tin ore is about thirty times more abundant than that of copper, though copper and bronze predominate in the accompanying slags (292). The tin ore paid well, one sample showing 43.3% of the metal, and included several varieties, such as alluvial cassiterite, fine cassiterite in quartzite, and the fine-grained chloritic ores known in Cornwall as "peach" and "ruby tin" (292).

Blaauwbank has yielded no finished objects in copper, tin, or bronze (292). Of metallic copper we find only one ingot from Smelter's Kopje, and a few impure prills which contain considerable arsenic and 2%-3% of tin. Metallic tin is more plentiful, comprising prills found in slag; several bun-shaped ingots, old and corroded, containing about 95% tin and a little copper, arsenic, and iron (246, 292); and several furnace bottoms (284) weighing about twelve pounds each (286). Two ingots of tin from the Camp Workings at Rooiberg analyze 95.3% of the metal. The smiths may have subjected the crude tin to a refining process after the first smelting (246).

The old Blaauwbank smelters used two kinds of furnace: a hearth, apparently for smelting tin and iron; and a crucible, probably for bronze and copper (292).

The hearth type has a clay saucer-shaped base about ten inches in diameter.

6. 161: p. 128.

Clay tuyeres at the bottom directed the draught from the bellows. Slag containing prills of tin was found in one of these hearths (292).

The crucible furnace, about seventeen inches in diameter, has a circular foundation of rough rocks set in the ground, the larger interspersed with the smaller in such a way as to distribute the natural draught. Within the circle a set of tapering stones supported the pot which served as crucible. Slags of bronze and copper, and in one instance a bronze prill, adhere to the crucible fragments (292).

Charcoal was the fuel in all cases. For fluxing the smelters used either quartz rock crystal or quartzite, both probably containing iron ore, as shown by the high iron content of the bronze slags (292); nodules of ferruginous aluminous surface limestone (67, 292); and possibly cobbed tourmaline (292). The large amount of metal left in all the slags shows the crudeness of the smelting technique (292). One piece of slag contained 3% of nickel (64).

A flat stone with a rough mould cut in it was found near one of the furnaces. Other finds at the smelting site include a grooved stone ball, a hoe of modern native type, and perhaps some human tibiae.

Though we cannot date or identify the miners, we should expect the smelting operations to be more easily datable, either by the presence of foreign objects or by the distribution of the metals smelted. Again we are disappointed. At Rooiberg, for example, where no metal implements have been found, ancient stone tools are particularly common. But they vary in type from Stellenbosch to Middle Stone Age, and nothing warrants their attribution to the Rooiberg metal-workers.

Baumann (19) has described an "ancient road" near Smelter's Kopje. If this really is a road, and as old as he believes, it is the only known monument probably to be associated with the tin mines. Starting from the neck which joins Smelter's Kopje to the Elandsberg, it ascends the Elandsberg northward, but has not been traced further than the summit. The builders cut it from the side of the hill, filling the excavated material in on the downhill side. Though now dilapidated and overgrown with vegetation, it was apparently wide enough to take a wheeled vehicle. Baumann ascribes this to ancient or foreign workmen, because the Bantu never build paths or roads, and "no Boer would climb over a hill when he could go on the flat round either end of the range." In the absence of adequate historical and archaeological data, this find can hardly be taken seriously.

We are thus urged to believe not only that many thousands of tons of copper and tin ore were mined before the seventeenth century in an area remote from civilization, where the natives now possess copper in very small quantities and no tin of their own at all; but that this ore was smelted so as to leave practically no trace of the smelting operations, or taken out of the country to some unknown place by people who left no mark in historical records and no foreign implements behind them. The whole situation makes us look silly. We feel that that there must be some very obvious solution, readily demonstrable by a short walk around the mines or a little elementary reasoning; but that we are as incapable of this reasoning as we are of taking the walk.

By this time the reader has thought of one explanation for this perplexing state of affairs, and I can hear him taking me to task for not suggesting it myself. Perhaps the natives mined these ores not primarily for their metallic content, but for their colors and lustre. Perhaps the many thousands of tons never came to the smelting furnace, but were lavished away on frizzy polls and satiny dark hides, to which they would impart the most dazzling shades of blue, green, and yellow. A proof of this would account for the selection of green malachite, cerulean azurite and cassiterite, and the metal-yellow sulphides of copper, and would incidentally spoil much of our metallurgical fun.

One point in favor of this idea is the fact that the old miners of the Transvaal exploited, in addition to the ores above mentioned, large deposits of micaceous specularite and red haematite. The former would provide a glittering powder for the hair, the latter a red paint for hair and body. Red haematite is especially common in the Bushveld. In one deposit the miners dug a continuous trench for about four miles, and tapped the same vein intermittently for several miles beyond (284). This may be the working near Malalane, on the Delagoa Bay Railway, from which, according to Trevor, 40,000 tons of red oxide had been removed (286). Though modern Negroes have occasionally tapped these workings, no native traditions account for them (284); and since they clearly resemble the large tin and copper workings in mining technique (284) — notably the care with which they were refilled — we may confidently place them in the same archaeological horizon.

Wagner (289), examining the extensive old workings for "blackish gray specularite" on and around farm Zandfontein No. 256 in the Transvaal, where some mines can be followed for more than fifty feet below the surface and where more than 50,000 tons of ore must have been removed, concludes that though some of the ore was probably smelted, most of it was probably ground up for use as pigment. Schofield (235), though he names no definite sites, says that the old miners sought not only gold, copper, iron and tin, but also rock crystals, corundum, yellow ochre, and plumbago.

Dart and del Grande say (69) that mica-

ceous specularite has been extensively used and traded as a cosmetic by Negroes in Southeastern Africa in recent times. I have looked through all my notes on costume and decoration for this area, and none of them mention the practice; but I am willing to take the word of two intelligent men working on the ground. Red ochre is a different matter: we have a number of references to its use by Bushmen and other South Africans, especially on ceremonial occasions.

Another clue might be taken from the large mullers and grinding stones found at the Rooiberg tin mines, which could have been used for preparing the ore as paint instead of for smelting.

But when we search for the actual cosmetic use of malachite, cassiterite, and copper sulphide, our ethnographic and historical data fail us. I have heard of only two possible instances where these puzzling ores might have been used as body paint; the blue applied by the boys in the circumcision schools of the Bomvana, and the malachite which Livingstone (161),[7] in the middle of the last century, found traded, along with copper and copper ornaments, from Katanga across the Nyasa and Shire country. The first is far to the south of the old mines; the second refers to deposits which we know have yielded numerous and widely traded supplies of copper. So conspicuous a habit as green, blue, or yellow body-painting could not have escaped the observation of foreigners at any date whatever; and until I read more of it in medieval accounts, later travels, or modern ethnographies, I shall refuse to accept it as an explanation for the great old mines.

HISTORICAL AND ETHNOGRAPHICAL RECORD: COPPER

Though we can find no evidence for the use of copper ore and tin ore as cosmetics, we do not have to search long for reports of the metals themselves. After the last decade in the fifteenth century, when Vasco de Gama rounded the Cape and put in at several places on the East Coast, we find copper mentioned here and there in Portuguese, Dutch, and English. On St. Helena Bay, northwest of the Cape, DeGama himself in 1497 saw Strandloopers wearing copper earrings, and in the following year dubbed the Limpopo the Copper River because of the abundance of copper ornaments among the natives at its mouth (105).

The sailors of the wrecked ship "Stavenisse" in 1687 (33, 55)[8] found the "Magossebe" wearing copper and iron rings, and reported that their chief riches consisted of copper and iron, which they wore as marks of bravery. These natives valued copper highly, however, for they traded to the sailors and their rescuers a fat ox or cow for a single copper arm-ring or neck-ring. Similarly, seventeenth century Dutch traders found in the Cape Hottentots a ready market for iron and copper goods. Dapper in 1668 (63)[9] wrote that the Namaqua wore earrings of copper, and that the natives of Mozambique had copper bracelets.

On May 22, 1724, the British at the Cape issued orders "to examine the Copper Mountains and minerals at the Rio de la Goa" (36), sources which had been brought to light by the metal which the natives possessed. Van de Capelle (19) says that the Negroes on Delagoa Bay in 1733 wore copper ornaments and knew good copper when they saw it, refusing the poorer stuff which was offered them in trade.

In the latter half of the eighteenth century, the Mabudu Tembe, who lived between the Mabudu River and the sea, worked iron and copper which they had obtained from the interior, and traded the finished goods to the Mtetwa under Dingiswayo and to the BaSuto. The copper, says Bryant (42),[10] came from old Negro mines along the Limpopo.

Campbell (285), in his account of his <u>First Journey</u> in 1813, states that the people of Kuruman and the northwestern Transvaal, "Lattakoo," get copper from "natives behind them," and that the "Wanketzanese" (BaNgwaketsi) (42)[11] obtain copper rings from their manufacturers on the east and trade them south to the "Matchipies." He suggests that the Lattakoo people got their copper indirectly from the Portuguese, though he knows of the "Copper Mountains" in South Africa. A few years later (239) he found the natives at Meribohwey, six days by wagon northeast of Lattakoo, smelting their own copper and wearing copper beads. On a map in Chapman's <u>Travels</u> in 1868, the mountains west of Rooiberg are marked as the Copper Mountains; and in the same year Britton (203) found natives smelting copper in the Mashishimali Hills near the Letaba.

In the Transvaal and Portuguese East we find hints of the recent diffusion of copperworking, which shows no continuity with the activity indicated by the ancient mines. Though the BaVenda say that their grandfathers worked the Messina mines, they look to the BaLemba as the leading ironsmiths, coppersmiths, and wire-drawers (159, 255).[12] They say that at first only the Venda chief's family and the BaLemba were allowed to wear copper ornaments, and that they feared the BaLemba so much for their superior intelligence that they never let them work on the chief's land, but made them pay tribute in pottery and ornaments instead (255). The BaLemba, actually superior to their neighbors in iron and copper working (232),[13] seem to have got most of their copper from Venda-

7. 161: pp. 128, 389.
8. 33: Vol. 1, pp. 43-46; 55: Vol. 1, p. 6.
9. 63: pp. 380, 399.
10. 42: p. 291.
11. 42: p. 92.
12. 255: pp. 62-68.
13. 232: p. 69.

land (159, 232). Some of them work as smiths far beyond Lemba territory (159). Junod (136, 159) believes that the BaLemba introduced copper-working among the BaSuto and BaThonga, and finds no reason for believing that the BaThonga knew copper before they knew iron (137).[14] The lateness of copper-working among the BaSuto is also attested by Endemann (89), who states that they imported most of their metals from the BaRoka on the north.

Far to the west the Ovambo, though they knew nothing of the copper deposits at Tsumeb (154), smelted copper from ore obtained near the modern mines in the Grootfontein district, chiefly for the massive leg-rings which their women wear (110).[15] In the old days the Ovambo chiefs of Ondongŏ held, by arrangement with the local Bushmen, the copper mines of Otavi, over which they waged many a battle with the OvaHerero (154).[16] The Great Namaqua Hottentot got most of their copper from the Little Namaqua to the south and the BeChuana to the east (230).[17]

Within recent decades in South Africa, importation of copper and brass has caused a decline in the native output. Trevor (284) doubts that in twenty years of experience he has seen as many as fifty pieces of copper which were undoubtedly produced by the natives, or that a ton of such copper could now be obtained in all of South Africa.

Katanga Copper

The greatest modern African source of the metal is the Katanga region, at the extreme southwestern corner of the Congo drainage and in the adjacent portion of Northern Rhodesia (150). Events in the first half of the nineteenth century divide the metallurgical history of central Katanga into two periods. Before that time, the BaSanga had here been the chief operators of the copper mines, and had exported large quantities of the metal eastward into Arab hands. Then came the BaLuba slave raids, a storm of tribal rivalries, and finally the BaYeke invasion.

According to tradition, the BaYeke, BaTushi and Bai had migrated to the Katanga from east of Lake Tanganyika, the BaTushi arriving first, the BaYeke at about 1850 under the leadership of the tyrant Msiri. The BaYeke having been kindly received and initiated into the mining mysteries by the BaSanga soon set up a little empire from the Luapula on the east to the Lualaba on the west, which, according to Ladame, cut off the BaSanga copper trade with the Arabs through Tanganyika. Having entered the Katanga very poorly equipped with powder and rifles, they discovered that these could be got from the Portuguese of Angola in exchange for copper and ivory. The BaLwena served as convenient middlemen for this westward traffic, but the BaYeke themselves organized expeditions as far as the Atlantic coast. Most of the old BaSanga processes were lost when the BaYeke supplanted the BaSanga as miners and smelters, and the BaYeke copper trade with the west never equalled in magnitude that of the BaSanga with the Arabs.

Ladame has apparently exaggerated both the decline of the copper trade with the east and the part played by the BaYeke in opening trade with Angola. Walker (294) cites Purchas his Pilgrimes to the effect that as early as 1625 an English sailor found copper being brought to Angola from the interior, to be shipped out at Benguella; and believes that this copper probably came from the Katanga, since the slave road from the Katanga to Benguella was already well worn. Unfortunately Walker does not give the exact reference for this, and I have been unable to find the passage. But as for the eastern trade, Livingstone (161)[18] in the early 'sixties found slaves, ivory, malachite and copper ornaments being traded from the Katanga ("under chiefs Cazembe and Katanga") through the Nyasa-Shire region to the Arab port of Kilwa and the Portuguese ports of "Iboe and Mozambique." A copper bar four feet long was offered him for sale at Chinsamba's location near Lake Nyasa (161). At the mouth of the Kaombe, near the same lake, he talked with four slaves belonging to an Arab who had lived for fourteen years in Chief Katanga's country, south of Cazembe's. They had brought both copper rings and malachite to exchange for cloth at the Lake, and told him that the malachite was quarried from a large vein on a hill near Katanga's (161). Stern (256, 34)[19] says that the BaNyamwezi recently obtained copper by trade from the Katanga, the caravans bringing it through the southwest of Tanganyika; though this trade has now been superseded by trade with the coast. According to Stuhlmann, copper was exported from the Katanga to Tabora and other parts of Tanganyika in X-shaped ingots, the largest of which weighed about fifty pounds (261).

A third line of export, followed probably in pre-BaYeke times, has been continued to the present day. The smelters on the left bank of the Lualaba — the only part of the Katanga region where copper-working is still very active — cast their copper in X-shaped ingots and sent these north and west to the tribes on the Lomani and the Kasai (116). Though European money has reduced the demand for native currency, these ingots reached such skilled artisans as the Bushongo (282), and such remote tribes as the Mangbetu and possibly Ashanti. Götz-Philippi of Madrid told Hans Himmelheber (119) that when he visited Ashanti and the Baoulé country at the beginning of the present century, Ashanti was making bronze of tin from Northern Nigeria and copper traded overland from the Katanga. This bronze was bought by the Baoulé and other neighboring groups. Some

14. 137: pp. 187-40.
15. 110: pp. 35-36.
16. 154: pp. 203-204.
17. 230: pp. 215-16.
18. 161: pp. 128, 389.
19. 34: pp. 161-65.

of the Katanga copper and Nigerian tin reached the Baoulé unalloyed. The Katanga may thus have sent its copper as far as the hinterland of the Ivory Coast, and at any rate has a unique significance in the history of native Negro trade.

HISTORICAL AND ETHNOGRAPHICAL RECORD: TIN

The Southeastern Bantu seem to have used tin much more extensively than any other Negro peoples. Vasco de Gama in 1498 found natives at the mouth of the Limpopo carrying daggers the hilts of which were embellished with this metal (105).

In 1723 Jan van de Capelle, an official of the Dutch East India Company at Delagoa Bay, reported to the Governor and Council of the Policy at the Cape (19, 203): "At the end of the year just passed natives have been at La Goa from the countries 'Paraotte' and 'Machicosje' who not only brought copper but also tin for purposes of barter; the copper was of very fine colour; the tin was of medium good colour, but somewhat brittle and light as may be seen from two samples of staves (bars or ingots); one of these is much harder than the other, as would happen if remelted. They state that the tin was found on the banks of a river in the country 'Machicosje', and is gathered in baskets, cleaned of sand and then smelted to bars for the purpose of barter. All the inland dwellers use this tin (also such as they buy from us), which they alloy with copper for the purpose of making necklets and bracelets. That is, no doubt, the reason why their ornaments have such a high polish and are more pliable than those of the Company."

In 1733 he gave one hundred three pounds of beads to the natives for fifty-six small bars of tin (19, 203). Since Rooiberg is only 250 miles due west of Delagoa Bay, Baumann believes that this tin came from Rooiberg (19). We may even suggest a much wider trade in Transvaal tin. Dapper (63, 178)[20] says that tin and lead as well as copper were obtained by Europeans from the natives at Loango. The tin may have been traded overland from the Transvaal, rather than from Northern Nigeria or from unreported mines in the Congo or Angola. Such far-flung commerce will amaze no one who follows the native trade routes over which Katanga copper has spread.

Campbell (285), in his account of his First Journey in 1813 — the first journey recorded by a white man north of the Orange River — states that the natives of Kuruman and the northwestern Transvaal, "Lattakoo," get tin as well as copper from "natives behind them." He suggests that both of these metals are of European importation through the Portuguese, though he knows of the "Copper Mountains" in South Africa. A few years later (285) he finds the natives at Meribohwey, six days by wagon northeast of Lattakoo, wearing ornaments of a white metal "resembling silver," and reports that they had "silver" and tin rings. In listing the articles made by the Baroutsie at Kurachane, however, he mentions iron and copper but no tin or bronze (203).

Moffat (285), who visited the Transvaal in 1830, after the Mantatese and Matabele had devastated large parts of the country, mentions tin-smelting by natives of the "Baconi" country, apparently east of the Marico. In 1826 he had seen an old Mohurutse smith near the Molopo make "brass wire by his own draw-plate" (19, 203). He says that the Baconi natives call tin moruru, and sold him some of very fine quality.

With regard to Moffat's statement, Mr. Griffith, the Native Commissioner as Rustenburg, replied as follows to queries about native metallurgy in his district (285): "The natives have mined for copper and iron, surface workings, but I have not been able to discover if they ever mined for tin. None of the natives whom I have spoken to know the work 'moruru' (given by Moffat for tin), but I am told that the flakes which fly from iron when it is beaten after heating are called 'morudu'. These were resmelted and beaten into wire with which bangles were made. This became much lighter in colour than ordinary iron. I have seen a native from Louis Trichardt district, who informs me that he knows for a fact that natives used to extract a white metal from stone, smelt it, draw it, and then draw it into strips of wire, from which they made bangles." In view of the several early accounts of tin in South Africa, from practical sailors, traders, and pioneers, who would certainly know tin when they saw it, Griffith's observations raise the question of the late disappearance of tin-working in the Transvaal, rather than argue against native possession of tin in former days.

Bronkhurst (203) in 1836 reports that not only were the natives north of the Transvaal mining and working gold and a great quantity of iron, but that the people in the Randsberg had good tin, which they called "white iron," and were making rings of it.

In about 1820, Natal Kafirs related an incident which suggests that natives this far south had only begun their acquaintance with tin. "Some years before," says Isaacs (129), "the natives had dug from the bowels of the earth a mineral which, when melted in their crucibles, turned to a beautiful glossy white, and was worked by them into arm-bangles. Before this, they had been accustomed to have them made of iron, with which the country abounds. The chiefs abandoned the black metal, and, as badges of distinction between them and their dependents, the former wore the white bangles, and the latter were

20. 63: p. 328; 178: p. xlvii.

consequently obliged to wear the black ones.

"At this period a number of the chiefs died. The 'inyangers', 'angus', wisemen or soothsayers [inyanga means shaman, iron- or coppersmith, or any skilled artisan (99)] were ordered to assemble, and immediately to discover the cause of their death. Several people were suspected of having administered poison to them, and were all killed without discrimination or without proof of guilt. The prevailing malady by which the chiefs had been carried off still continuing, and innumerable natives having been destroyed under the impression of being the cause of their death, or being, according to their designation, 'Umtugartie', that is, 'evil-disposed persons', they decided that the white metal worn by the chiefs was the cause of the death of that class of persons, which put an end to further executions of the innocent. The individuals, however, who had discovered the metal, and those who had fabricated it into bangles were condemned and executed. The bangles were also commanded to be returned to the earth ... and orders were issued that in future no white metal should be dug up without subjecting the offender to capital punishment" (241).[21]

THE PROBLEM STILL UNSOLVED

We may conclude from these scattered references that tin was being smelted and used in the Transvaal between the fifteenth and the nineteenth centuries, that it was exported to the coast and possibly northward and eastward; but that further south it was scarcely known until the coming of the whites.

The problem of the ancient mines, however, still remains unsolved. It is largely a quantitative one. Were the four or five centuries represented by European records, and the extensive trade relations which South Africa has maintained with native cultures to the north, sufficient to absorb the many thousands of tons of metal that must have been extracted? It is hard to believe that they were.

As we have seen from the references to Kalah in my chapter on early iron, Arabs were seeking tin in the ninth century, and they were probably looking southwestward as well as eastward. They had reached Sofala (146) at the beginning of the tenth century, within the great Zimbabwe period. If they were taking tin out of Malaysia, why should they not have taken tin and copper from the Transvaal and Southern Rhodesia, not far inland from Sofala? Arab traders travel very light and would leave few tell-tale objects behind them.

The most serious objection to this idea is the absence of any reference to African tin or copper in all Arab accounts which I have examined. Mentioning the iron and gold so frequently, they certainly should have recorded the other two metals had they been taking them out of Africa in any quantities.

This objection holds nearly as well against an alternative possibility — one which I scarcely dare to mention — the exploitation of the metal deposits by Indians and Malays. If we can trust Idrisi, Indian traders reached the East African coast in the Middle Ages; and Ibn Sa'id knew of the colonization of Madagascar. The latter folk-movement thus probably continued into the trade era represented by Zimbabwe, and may not have long antedated the earliest mining in the Transvaal. But the Arab authors who were so familiar with trade to the Indies say nothing of tin or copper passing eastward.

The earliest such record which I have found is that of Dapper in the seventeenth century, who says that both gold and copper were traded out of Malindi to the Indians of Cambaye. This copper undoubtedly came from the Katanga through the hands of the Ba-Nyamwezi, the great traders and porters between Lake Tanganyika and the coast. Thus metals could pass from Central Africa to India with no European stimulus or aid. If in the seventeenth century, why not in the seventh? And if from the Katanga through Malindi, why not from the Transvaal through Zimbabwe?

21. 241: pp. 355-87.

VI. COPPER

GENERAL DISTRIBUTION

Unlike Asia, Europe, America, and North Africa, Negro Africa has employed copper and its alloys almost entirely for ornamental purposes and as media of exchange. This absence of copper blades favors the old truism that the Negroes passed from the Stone Age directly into the Age of Iron; or, in less pretentious terms, that whenever they discovered copper they had long been using iron for practical purposes, and had no reason to make weapons or implements of the softer, rarer, and more decorative metal.

Negroes mined and smelted copper in four main areas: the Transvaal, the Katanga, Angola and adjoining parts of the Congo, and the Azande territory. Except in a few cases, smiths in other areas got their copper by trade: in Tanganyika and most of the central and eastern Congo drainage, from Katanga; in the northern Congo, from certain mines in the Sahara and Sudan, as well as from the south. Copper from European or Arab trade has reached every part of the continent, and has filled the market in West Africa, where the local sources were probably never worked. We have already done what we can with the copper problem in the Southeast. Let us now review the distribution of this metal in other parts of Negro Africa.

KATANGA

Katanga copper supplied native smiths over an immense area. It was not only traded eastward through the BaNyamwezi and into Arab hands, but reached the Atlantic coast and the northern grassland borders of the Congo (134).[1] As I have already remarked, bronze made in Ashanti probably contained Katanga copper. If this is true — and in view of other reports of the northward trade, I see no reason to doubt it — it is one of the most spectacular instances of overland commerce among primitive peoples. Rickard (219) believes that a passage in Purchas his Pilgrimes, cited by Walker as evidence of Katanga copper being exported to the Atlantic coast in the seventeenth century, refers to copper from Bembe in northern Angola. But men still alive in the Katanga remember taking copper to the shores of the western ocean (219), and there is no reason why such trade should not have been carried on three centuries ago.

SOUTHWEST AFRICA

Roos and Marais (230)[2] observed copper working among the Naman Hottentot only after the latter had had much contact with the Bantu. They write that the ore was smelted in a clay crucible over a small fire on a hearth of cowdung. The molten metal was then poured into moulds of cowdung three or four inches in length, producing small copper bars of a standard shape. These bars were beaten into ornaments with a stone hammer and anvil. The Naman hired Herero smiths to work iron and copper into beads, paying the smith one ewe per day (230). In the eighteenth century, the Naman worked only a little metal, obtaining most of their iron and copper things from the OvaHerero and BeChwana by barter (230). The Great Namaqua got most of their copper from the Little Namaqua on the south and the BeChwana on the east (230).

EAST AFRICA

Modern copper-working fades out northeastward in the regions around Lake Nyasa. Livingstone (161)[3] found copper smelted with a flux by tribes just west of the lake; but according to Stannus (178), the WaHenga in the north, working copper, and the tribes near the Zambezi who work brass, are the only Nyasaland smiths working metals other than iron. Both groups use crucibles, and probably import copper and brass from the coast, and some copper from Katanga as well.

Pigafetta, in the sixteenth century, mentions copper as one of the commodities which the natives of Mohenemugi, north of Monomotapa, traded for foreign silks (209). This is probably the Nyamwezi country, since Pigafetta locates it west of Quiloa, Malindi, and Mombasa, south of Abyssinia ("the kingdom of Prete-Gianni") and "between the two lakes." The copper probably came from Katanga. In 1668 Dapper, compiling from a number of sources (63),[4] wrote that the kingdom of Monoemugi or Nuueamaye in the interior north of Monomotapa included mines of gold, silver, and copper (209),[5] and that rich native merchants at Malindi were trafficing with the Indians of Cambaye in "gold, ivory, copper, mercury, and every sort of stuff."

Farther north in East Africa, the copper obtained from overseas seems to have far

1. 134: p. 800.
2. 230: pp. 315-16.
3. 161: pp. 536-37.
4. 63: pp. 380-401.
5. 209: p. 514.

exceeded that derived from the African interior. Van der Burgt (43)[6] believes that the WaRundi received it from the east coast and from Abyssinia before the modern Arab trade. Their neighbors, the WaVira of the northeastern Congo (43) and the WaTwa of central Urundi, melt down the copper wire obtained through trade with the eastern littoral and the WaNyaturu derive their copper from the same direction (218).[7] Among the Lango (82),[8] copper is worked only by the highly skilled Abwor and Akwa smiths, a fact suggestive of its foreign derivation.

CENTRAL AFRICA

Our data from the Conga and Angola leave us quite uncertain as to copper-working in the old native cultures, for the references are very scanty, and the earlier writers seldom took pains to inform us how much was done by natives independently and how much was the result of European exploitation.

Apparently some of the Angola peoples worked copper, though they did not value it very highly. Andrew Battell in the seventeenth century (16)[9] says that the kingdom of Angola was very rich in copper, and reports mines in the mountains of Cambamba, which "lie along the coast south and by west. Here is a great store of fine copper, if they would work it in their mines, but they take no more, than they weare for a braverie." The "braverie" for women consisted of heavy torques, and rows of rings on their forearms and calves. Pigafetta (209)[10] tells us of many copper mines in the country of the Anzigues beyond the kingdom of Loango, and Battell of rich sources in Bongo province, east of Longeri (16). He bought very fine copper from natives at the Bahia de la Torre (Bahia de las Vaccas) on the coast of Angola. Dapper, at about the same time, reports a number of copper mines in the Congo (178).[11] Most of the copper brought out at Loango came from the province of Sondi, far in the interior on the way to Pombo. Dapper (63)[12] says that Europeans in the seventeenth century took it from mines in the Lemba district, on the borders of Goi; and that good copper was also found in Sango in the Pemba district (Bembe? [128][13]). Mines near San Salvador produced a very yellow copper which some Europeans mistook for gold (63). These were probably in the well-known malachite fields south and southwest of the town (30).[14]

In modern times the BaKongo, northwest of Manianga above the Congo cataracts, have mined copper sulphide ores (20)[15] and cast the metal into ingots, about four inches long and three-fourths of an inch thick (30),[16] which are traded between the BaKongo and the BaBwende, and between the BaTeke and Ba-Nyanzi (134).[17]

Most Congo tribes import their copper. All BaTetela groups, for example, smelt only iron, though they work in copper as well (277). Among some, copper is a very recent possession. The BaLuba, Bushongo, BaSongo (198),[18] and others probably got it first by trade from Angola and the Katanga. It seems to have reached the tribes southwest of the Kasai only within the last few generations (283).[19] The BaPende secure most or all of their copper from European trade on the coast (283), which began at least as early as the end of the sixteenth century. Weeks in 1909 (297) found that the BaNgala knew copper, calling it likulu or dikulu, but did not work it or wear it as ornaments, though they worked in brass.

Johnston says that there are forges for copper and brass, as well as for iron, at almost every village along the Aruwimi (134).[20] The Bopoto people value copper highly, work it with great skill, and hold more or less of a monopoly on copper necklets, bracelets, and chains in their neighborhood (134).

NORTHERN CONGO AND CENTRAL SUDAN

As for copper in the northeastern part of the Congo drainage, information is scant and somewhat contradictory. Johnston (134) suggests that its working was introduced into the Ubangi-Wele basin by Negroids from the Upper Nile and Bahr el Ghazal. Apparently no copper ores occur in the Wele Basin (62, 134),[21] and those in Mangbetu territory are not workable (199).[22] The Azande, however, work abundant deposits of copper silicate (28). Lacking mines of their own, the Mangbetu before 1834 seem to have derived most of their copper from far to the south, from Katanga or Angola (199). Schweinfurth (236) says that the Mangbetu king had a great mass of copper before that date. They also probably acquired some of the metal from the Azande. The Ababua got red copper from the Budza, rarely dug the ore for themselves in shallow mines; but now use European brass in its place (111).[23]

Most of the copper used north of the Congo drainage seems to have been imported from outside the Negro area. In spite of rumors of copper mining and smelting among the Baya of the Cameroon, no corroborative evidence has been found (274).[24] After the Furawi raid of 1834, the Mangbetu were open to trade with the Muslim tribes of Darfur,

6. 43: p. 52.
7. 218: pp. 58-59.
8. 82: pp. 86 ff.
9. 16: pp. 375, 389.
10. 209: p. 424.
11. 178: p. xlvii.
12. 63: pp. 340, 348.
13. 128: pp. 265-66.
14. 30: p. 46.
15. 20: p. 164.
16. 30: p. 46.
17. 134: Vol. 2, p. 805.
18. 198: pp. 223 ff.
19. 283: p. 348.
20. 134: Vol. 2, pp. 800-805.
21. 62: Vol. 2, pp. 129-30.
22. 199: pp. 265-71.
23. 111: pp. 233-39.
24. 274: p. 185.

from whose mines around Sakara and Hofrat en Nahas on the Upper Bahr el Arab they have since secured large quantities of copper in rings and other conventional forms (56, 199).[25] They now rework European copper wire. Barth (14)[26] reports that much of the copper and zinc traded in Kano came from Tripoli, and much of the copper from El Hofra, whence it was brought by the Jellaba of Nimro in Wadai. The quantities thus imported were enormous, but most of the material was retraded out of Kano.

The El Hofra workings themselves may be only recent. As late as the beginning of the nineteenth century, Darfur and Wadai seem to have been importing most of their copper from the Mediterranean world rather than from any nearby sources. Sheikh Muhammad ibn 'Omar et Tunsi, who visited the region at that time, reports that scrap copper commanded a high price there, and was the most profitable article of trade (287).[27] At Dar Raunah, he says, three rotls of red copper bought a male or female slave. Secondary imports were zinc, money of various metals, and brass. According to native traditions of the fall of Kash in Kordofan (96), however, the mines of Hofrat en Nahas flourished under the reign of Nap of Naphta (Napata?), who exported much gold and copper through Nubia to the outside world. The local workings now appear as a number of pits, some as much as a hundred feet long and from ten to twenty feet deep, over an area of half a mile square (59).

In 1352, Ibn Battuta (17)[28] describes the copper trade to Negro lands from Takadda, an oasis in the Southern Sahara which has not been precisely identified in modern times, but which is usually located somewhere south of Air or Agades. These mines are also mentioned by al-'Omari (194)[29] in the words of Sa'id ez Zawawi as follows: "The Sultan Musa of Mali told me that he possesses a town called Tigidda, where there is a mine of red copper, which is imported in bars to the town of Nyani (Mali). The sultan said that there is nothing in all his empire that yields taxes equal to those yielded by the importation of this crude copper. It is taken only from this mine, never from any other. We send it (said he) to the country of the pagan Negroes, where we sell it at the rate of one mitqal' for two thirds of its weight in gold, exchanging a hundred mitqal' of this copper for sixty-six and two thirds mitqal' of gold."

"At Takadda," says Ibn Battuta, "the water flows over copper deposits which change its color and taste.... The people of Takadda have no occupation except trade, and travel every year to Egypt, to import everything obtainable there in the way of fine fabrics and the like.... From a mine outside Takadda, their male and female slaves dig copper ore and bring it into town and smelt it in the houses, producing red copper, which they make into rods of a span and a half in length, some thin and some thick. Four hundred of the thick bars, or six or seven hundred of the thin, are sold for a mitqal' of gold. Using these bars as currency, they buy meat and firewood with the thin ones, and male and female slaves, dhurra, butter and wheat with the thick ones. From Takadda copper is exported to the city of Kubar in the land of the pagans, to Zaghai and the country of Barnu. Barnu is forty days' journey from Takadda. Its people are Muslims, with a king called Idris, who does not show himself to the people and speaks to them only from behind a curtain. From this land of Barnu are brought beautiful slave girls and youths, and fabrics dyed with saffron. Copper is also exported from Takadda to Jujua and the country of the Murtabun and the like."

Gibb (102)[30] discusses Takadda as follows: "Tagadda or Takadda was at this time the largest town in the Tuareg country. Its Berber sultan, who was nominally subject to the Emperor of Malli, is probably to be regarded as the ruling chief of the Massufa (Sanhaja). The problem of the site of Tagadda is not yet cleared up. It is generally taken, on the basis of Barth's identification, to be Tegidda n'Tisemt, 97 miles W.N.W. of Agades. Barth added that although 'nothing is known of the existence of copper hereabouts,' a red salt is obtained from mines there. Gautier and Chudeau ('Missions au Sahara', II, 257) also remark on the absence of copper in the Sahara except at Tamegroun in the Ougarta range (29.15 N., 1.40 W.), and state that all the copper used in Air and in Ahaggar comes from Europe. The absence of copper at Tegidda is confirmed by F. R. Rodd, who thinks that Ibn Battuta's Tagadda must be looked for 'at some considerable distance south of Agades' ('People of the Veil', pp. 452-456). The meaning of the word Tegidda, according to the latter, is 'a small hollow where water collects,' and the name is applied to a number of different places (cf. H. S. N., II, 193; Marquart, 98)."

Gibb (102) identifies Kubar with Gobir, north of the modern Sokoto, and consequently just south of Takadda. He does not know whether Zaghai refers to the district southwest of Timbuktu or to the central areas around Kanem and Wadai, vaguely known as Zaghawa. He says that Barnu does not mean Bornu in Nigeria, but rather Kanem, an empire which at this time extended westward across the Central Sahara to Fezzan, eastwards toward Darfur, and into Northern Nigeria. Idris, he explains, was the son of a certain Ibrahim Nikale, who claimed South Arabian ancestry and was sultan of Kanem from 1307

25. 56: map at end of volume.
26. 14: Vol. 1, p. 521.
27. 287: pp. 338-40, 379-80.
28. 17: Vol. 4, pp. 440-42.
29. 194: pp. 80-81.
30. 102: pp. 377-83.

to 1326. Gibb says that Jawjawa (Jujua), more often spelled Kuku or Kawkaw, is the Gaogao of Leo Africanus, and either Kuka in Bornu or another Kuka on Lake Fitri in Wadai, southeast of Kanem. He knows nothing of the Muwartabun or Murtabun.

WEST AFRICA

West Africa, even more than the Central Sudan or East Africa, has drawn its copper from outside the Negro area. El Bekri in the eleventh century (178)[31] says that copper rings were cast in Igli, the chief town in the province of Sus el Aqsa, in Southern Morocco, and were exported to the "land of the heathens" — that is, to Ghana and the countries beyond. He mentions copper, with salt, shells, and euphorbia, as a chief article of trade at Kuga on the Niger. Idrisi (86)[32] tells us that copper was brought with sea-shells to Tekrur by traders from Morocco to exchange for gold and slaves.

An unknown author in the geography compiled by Yaqut says that caravans going down from Sijilmassa to the gold lands of the Western Sudan carried among other things, armrings, earrings and seal rings of copper for trade to the Negroes (178).[33]

Leo Africanus (3)[34] writes of Ifran in Numidia: "The inhabitants are verie rich, for they have traffique with the Portugals at the Port of Gart Guessem, whose wares they carrie to Gualata and Tombuto (Iwalaten and Timbuktu). These castles (at Ifran) containe great store of inhabitants, which make certain brazen vessels to bee solde in the land of Negros: for they have copper mines in sundrie places thereabout." This passage reminds us of the copper vessels which, with armlets and other objects of copper and silver, were unearthed "in the remains of a house or tomb two feet below the surface sand" near Surami in Sokoto, and claimed by Meek to "point to a Mediterranean influence of a remote period" (182).[35]

In the year 1505, Pacheco Pereira (178) reports that the Portuguese traders bought on the West Coast "blue beads with red lines which the Negroes call coris," giving bracelets of brass and copper in return, and traded the coris for gold with the natives at El Mina. He says that a slave could be purchased at Gwato for twelve or fifteen copper manillas. Between 1538 and 1591, James Welsh, visiting Benin for purposes of trade, found Benin importing "manillas or bracelets of copper" (178). Dapper (63)[36] in 1668 mentions copper being traded by Europeans to natives all along the west coast, from the Senegal to Benin.

At the present day most tribes of West Africa obtain their copper through European trade. We find this stated or implied for the Lobi (228), who got copper from the Ivory Coast; for the Senoufo, who secured it through the Kong (32);[37] for Yatenga (even before the French occupation) (264), for the Bambara, Mossi, Ibo, Edo, and Yoruba (131).[38]

In view of the absence of copper mining and smelting in the Western Sudan and the West African forest region (133),[39] we may be practically certain that the rich copper-working cultures found by Desplagnes in tumuli on the Central Nigerian Plateau, and which he more or less identifies with the Ghana civilization, received the metal from trans-Saharan sources.

COPPER SMELTING

In discussing the archaeological remains in the Southeast, I have already mentioned the difficulty of smelting copper sulphides, but have reserved the general discussion of copper smelting for this place. Owing to the paucity of data, it will have to be very brief.

The BaYeke of Katanga (116) give us our best example of malachite smelting. Their processes differ from those used in eastern Katanga and formerly by the BaSanga of the same district, since they have apparently modified and adopted the older techniques after their own arrival in the middle of the last century. The BaYeke furnace, smaller and more fragile than the others, is destroyed after each operation, has no direct drainage channel for the molten metal, and, since it is built in the open instead of under shelter, can be worked only in the dry season. These features may be eastern ones, brought from an area where smelting is less developed, or they may be due to the warring conditions under which the BaYeke have lived, constant danger of attacks making a permanent furnace unpractical.

In a busy season the BaYeke may erect near their copper mines as many as twenty or thirty furnaces, around which the whole community camps. Each furnace is a hollow pile of small termite cones, seventy-five centimetres high and forty wide, propped on the outside by forked poles. The tuyeres are made of similar cones bored through and shaved flat on one side. Before the walls are built, three tuyeres are laid on the ground pointing into the shallow excavated bottom of the furnace. The whole construction takes about half an hour.

The smelters fill the furnace with charcoal which they have made from mobangi and other woods by burning in a pit and quenching with water. These hard woods used by the BaYeke produce a charcoal which agglomerates in a troublesome way with the fused

31. 178: pp. clxxxviii, clxxxii, clxxxi.
32. 86: p. 12.
33. 178: p. clxxxvii.
34. 3: Vol. 3, Book 6, p. 777.
35. 182: Vol. 1, p. 58.
36. 63: pp. 220, 300, 305, 310, 315.
37. 32: Vol. 1, p. 79.
38. 131: pp. 119-20.
39. 133: Vol. 1, p. 75.

copper, unlike the softer woods used by the BaSanga. Having lighted the charcoal, the smelters pile upon it about fifty kilograms of malachite, broken to pieces about the size of small hens' eggs. When this ore has been thoroughly roasted by two and a half hours of firing under a natural draught, they place in front of each tuyere a pair of bag bellows with a tube of fresh wet bark encircling the mouth, blow up the fire, stop the interstices of the furnace wall with clay, and continue to work the bellows till the smelting is complete. This final stage usually takes only half an hour. They then break away the furnace to expose the pool of molten copper lying in the bottom. The process is thus neatly divided between the dehydration of the ore, accomplished before the interstices have been stopped and the bellows engaged, and its reduction in a more or less closed furnace under a forced draught. From the fifty kilogram charge, which is about 40% copper, the smelters extract from twelve to fifteen kilograms of metal, 50% or 60% of the copper actually in the ore. They say that formerly the furnace was a metre high and produced about thirty-five kilograms of copper, more than one man could carry.

The above process, when viewed with a technical eye, may help to elucidate copper smelting elsewhere in Africa. Malachite is a basic cupric carbonate which has been formed by the weathering of other copper ores — chiefly sulphides — hence its superficial occurrence, when the others usually lie at greater depth. Nature favors the Negro smelters not only by presenting at the surface of the ground an ore conspicuously green, but one which, of all the copper series, is the easiest to smelt. Malachite is a comparatively unstable compound of a metallic oxide with carbon dioxide, and releases its carbon dioxide long before the charge has reached melting temperature. The copper oxide then gives up its oxygen to the fuel to form more carbonic gases, and the molten metal sinks to the bottom of the furnace. Malachite thus requires no preliminary roasting to transform natural sulphides into oxides so that they can form a light, fusible slag; no formation of a heavy matte of artificial metallic sulphides which will sink free beneath the slag and will have to be treated further to release the copper. The roasting practised by the BaYeke, therefore, seems to differ in purpose and results from roasting in the modern technical sense. In heating their ore under a natural draught, the BaYeke simply drive off the water content set free some or most of the carbon dioxide, and perhaps oxidize any copper sulphides that may be accidentally present, thus rendering them more amenable to smelting. I fail to see what else could be gained by applying this oxidizing technique to pure malachite at this stage of the process. The loss of 40% of the copper is obviously due to lack of a basic flux to neutralize the acid silicates in the gangue and form a slag which would mechanically release more of the copper, allow it to sink to the bottom, and seal it against further oxidation. The old Messina copper workers used such a flux and probably suffered much less waste.

The process noted by Ladame (150), though not precisely attributed, has several features suggesting the BeYeke method. He says that the Katanga smelters pile up alternate layers of incandescent charcoal and ore, building the clay wall to keep pace with the growing stack till the latter is eighty centimetres high, when they cover it with clay. They then pierce the wall with several holes for tuyeres, through which they work the bag bellows. After three or four hours of smelting they break down the furnace or lift it off. It seems that the dehydration of the ore takes place as the furnace is being built, when the ore and burning charcoal layers lie more or less open to the air. Ladame pictures a smelting furnace on the road from Morilo to Lake Mweru. It is apparently ten or twelve feet high and has seven or eight apertures at the bottom, hardly the type which he describes in his text.

Instead of the small temporary structure like that of the BaYeke, the BaSanga (116) built a furnace 1.75 metres high and one metre in diameter. The material seems to have been the same as that of the BaYeke furnace — termite earth — but the pieces were more reguler and more carefully fitted. De Hemptinne describes them as "baked bricks" — almost certainly an error. A furnace which had been used several times may have been burned hard; but the use of baked bricks seems unaccountable in a Bantu culture, unless from direct European influence. The BaSanga furnace stood under a shelter, had a hole at the bottom so that it did not have to be demolished each time the metal was taken out, and was worked with four pairs of bellows.

The BaLuba and other copper-smiths on the Lualaba, who still produce copper for export, employ a smelting technique which probably tallies closely with that of the old BaSanga. Gutzeit (108) says that the BaLuba men first crush the ore in wooden mortars, and that the boys then wash it at the stream in large trays with an undulating rotary motion, or by the "Hancock jigg" method in a basket moved up and down in the water, so that the lighter gangue will be carried away by the stream. Other authors explain that the malachite, having been washed in the river by women, is roasted on an open wood fire and carefully sorted. Though we have no adequate account for the BaSanga, they probably followed this roasting process, for they lacked the ingenious method by which the BaYeke aerated their furnace for dehydration. The BaLuba and their immediate neighbors build a permanent smelting furnace in a hut, about the size of the BaYeke refining furnace later to be described, with a hole and channel leading into a cross-shaped clay mould which can make a number of successive castings without being deformed. They close this outlet with ash paste and re-pierce it at each smelting. Since the bellows have no

special aperture for the intake of air, their nozzles must remain at some distance from the fire.

"The copper smelters at Hofrat en Nahas used equal parts of picked copper oxide ore, iron ore from local sources, and old slag shot with copper pellets. The iron ore served as a flux" (38a).

Gutzeit (108), describing the technique of the BaLuba on the right bank of the Lualaba, says that the smelting is performed in a termite hill cut with a narrow vertical chimney and a hole sloping downward to the outside. After charging this with alternate layers of charcoal and ore, the smelters close the aperture with leaves and apply the bag bellows. The smelting apparently goes on throughout the night; Gutzeit went off to see a dance as soon as the process had started. The pieces of crude copper are later melted down under the bellows draught in a smaller clay furnace, from which a narrow channel slopes down into the cruciform clay mould.

Somewhere in Katanga Lemaire (142, 152) found an abandoned smelting furnace containing a clay crucible, beneath which eight clay flues were placed radially. I doubt Klusemann's statement (142) that iron as well as copper was smelted by the Katanga natives in crucibles.

It is remarkable that none of the above descriptions of Katanga copper smelting mention a flux, though we know that the old Messina smelters used one. Only Melland (184), referring to the northern BaKaonde of the Kasempa District, Northern Rhodesia, says that lime is added to the charcoal as a flux for smelting copper, never for smelting iron. West of Lake Nyasa (161)[40] Livingstone in the early 'sixties found natives using a flux to smelt copper from malachite. These modern fluxing processes may be survivals of the old Messina technique, which the Katanga people modified because the abundance of malachite rendered the economy of a flux unnecessary, or because they had no lime to use.

Further east, in the Congo, the defects of native copper smelting were obvious to early explorers. "In the month of September," says Dapper (63)[41] in the seventeenth century, "a group of smiths leave for Sondi, and having arrived at the mountains where the copper mines are, they put their slaves to work. They smelt and refine this copper on the spot, but since they have not the skill to separate the different metals, which are sometimes mingled in the bowels of the earth, that is the reason why their copper is not very pure. Some have wished to give them good smelters to accompany them on their journey, to teach them what has to be done. These smiths return in the month of May, bringing elephant tusks as well as the copper."

The smelting of copper ores other than carbonates presents one of the most puzzling questions in the field of Negro metallurgy, and brings to light several aggravating gaps in our data. Bellucci (28) says that though the copper silicate of the Azande territory is poor in metal, the Azande reduce it without difficulty. Since the formula for the ore is $CuSiO_3$ plus 2 H_2O, apparently the water content is first driven off; then one atom of oxygen is taken over from the copper silicate by the carbon monoxide from the charcoal, forming carbon dioxide gas; and, since iron stands higher than copper in the electro-chemical series, the silicon (SiO_2) leaves the copper and combines with iron from the gangue. I am not at all sure of this reaction, for Bellucci gives no data on the ore or the Azande smelting methods. An inspection of the old copper mines of the Transvaal would lead us to believe that the workers there did not understand the smelting of copper silicate, since they seldom removed it.

Though the old miners in South Africa preferred copper carbonate (294), they did mine sulphides also (286). The pieces of copper sulphide in the slag heaps at Messina may have been brought to the furnace accidentally; but the ores deliberately mined at The Guide in the Palabora area, which may have yielded only 2% of copper, were sulphides widely disseminated in pyroxenite (286); those at Wagon Drift were bornite, another sulphide of copper and iron (286). Aside from the evidence presented by these old miners, we have only a single doubtful reference to the African smelting of copper sulphide: by the BaKongo, who are said (20) to have mined this ore north of Manianga and to have reduced it by a secret process.

Copper sulphide ore owes its intractability to the invariable presence of iron sulphide in intimate mixture, and to the fact that both compounds, after losing some of their sulphur in the first heating, melt and sink together when the heat is increased. The smelter needs to remove the iron from this mixture and to drive it into combination with silica, so as to form a light, fusible slag which will free the copper sulphide for reduction to metallic copper. Now silica has a far greater affinity for the oxides of metals than for their sulphides, while sulphur clings more tenaciously to copper than to iron. The modern smelter therefore proceeds by three stages.

Stage 1. He first partially converts the sulphides to oxides by slowly roasting the ore in a temperature not high enough to melt it. This gives iron oxide, copper oxide, and copper sulphate.

40. 161: pp. 536-37.

41. [Manuscript defective.]

Stage 2. This part of the process, aiming to produce matte and slag, requires the addition of silica, usually in the form of quartz. Under a much greater heat than in roasting, the copper oxide readily exchanges its oxygen for sulphur or forfeits it to the carbon of the fuel. Some of the iron also takes on sulphur, both metals thus mixing in the artificial sulphides called matte. Since white-hot silica has a special affinity for iron oxide but not for copper oxide, it unites with some of the iron oxide and other basic compounds to form a slag, while most of the copper oxide is, as we have seen, exchanging its oxygen for sulphur. Surrounded by the powerful reducing atmosphere of carbon monoxide gas, the copper which fails to react to the sulphur is giving up its oxygen and is dripping to the bottom of the furnace as metallic copper. Above this small copper pool gathers the next heaviest mass, the matte of iron and copper sulphides, while the slag settles lightly over all.

Stage 3. From the matte the metallic copper is extracted by a further process of smelting, which takes advantage of the fact that copper and sulphur have so great a mutual affinity that they will remain together while the iron sul hide oxidizes completely. As before, the resultant iron oxide combines with silica to form a slag. Prolonged smelting then oxides the copper sulphide, driving the sulphur off as sulphur dioxide gas and leaving metallic copper.

The above is only the roughest, most idealized sketch of the modern smelting of copper sulphides. It may seem so sophisticated as to be entirely irrelevent, but I have not learned of any other profitable method. It might conceivably be simplified by omitting stages 1 and 2; and by treating the primary iron-copper sulphides as in the last stage of modern smelting, where the iron sulphide oxidizes and slags away with the silica flux before the copper sulphide oxidizes to leave metallic copper. But it would seem difficult to set free this molten sulphide mixture in worthwhile quantities. Peters (207) describes what happens when copper and iron sulphides are fused together in a furnace:

"Long before the coke of the furnace charge has burned away, the easily fusible sulphides (pyrite and chalcopyrite) will lose the proportion of sulphur already indicated, and will melt together into the new artificial sulphide called matte. The matte globules are so heavy and so liquid that they will drip down through the ore column wherever they can find a passage, and those which succeed in reaching the bottom of the furnace will collect into a pool in the usual manner; but the greater part of the globules will become entangled among the fragments of quartz, and, although properly melted into matte, will be unable to separate themselves from the unmelted rocky portion of the ore, and will remain scattered throughout its mass.

"As quartz is infusible at any temperature reached by the copper smelter, it will simply remain unchanged, or slightly softened on the surface, where it becomes a little fluxed by the lime and iron oxide contained in the ash of the coke. The charge is unable to melt at the bottom, and to sink regularly in the furnace shaft, as it should normally, but will remain stationary and practically unchanged until all the coke has been consumed. When this sole source of heat is gone, the cold wind blown into the furnace will simply assist in cooling it, and the furnace is 'frozen up', being filled with a lava-like skeleton of superficially fused rock containing disseminated globules of matte."

I have discussed this problem with two competent metallurgists, Mr. Michael Yatsevitch and Mr. L. R. van Wert, and have received somewhat differing answers. Mr. Yatsevitch tells me that copper sulphides were smelted in ancient Spain by a primitive process, preceded by a very slow soaking in sea water; Mr. van Wert, that they could be smelted easily and directly in primitive furnaces. I am not inclined to attribute either to Negroes or to Asiatic miners the complex process involved in modern copper smelting as described by Peters, and therefore believe that whatever processes were employed in the Transvaal and the Congo must have involved a considerable waste of copper in the slag — possibly yielding only a few beads of copper which could be broken from the frozen contents of the furnace. But I leave the final answer to the metallurgists, or to those who will make a careful study of smelting refuse in Southeast Africa.

CRUCIBLES AND FLUXES, AND THE RELATION OF COPPER TO IRON IN THE SOUTHEAST

The subject of crucibles is a most suggestive one for the history of Negro metallurgy, and though it does not strictly belong in a chapter on smelting, we may profitably consider its pertinent aspects here. A crucible not only guards against the loss of molten metal, but allows a somewhat finer control of the proportions of metals, ores, and fluxes than is possible in a simple furnace. On the other hand, it imposes a certain practical limit on the amount of metal which can be treated at one operation.

Crucibles came early into Negro industry. One would expect that ancient specimens would always retain some trace of the metals melted in them; but either this is not the case, or archaeologists simply neglect to observe. Van Riet Lowe (162), in describing the contents of the old stone huts in the northern Orange Free State, confesses ignorance of the use of the little stone crucibles which he finds there. In this case, the green of the adhering slag suggests copper; but he prefers to believe that the metal was iron, though he admits that in so small a crucible it would take twenty or thirty smeltings to produce enough iron for a single assegai head. The smelters

on Blaauwbank in the Transvaal, as we have seen, used a crucible probably for making bronze and perhaps for smelting copper. It was small, and rested on a circle of tapering stones in the center of their little furnace. Caton Thompson (50)[42] found gold and bronze in the small crucibles unearthed in the Mauch Ruins at Zimbabwe. Among modern groups, the OvaMbo use a crucible in the primary smelting of iron (4),[43] the "Southern Bantu" (300) for its refining. Further north, the BaNgala of the Upper Congo (298) smelt iron by filling a crucible with ore and placing it, surrounded with charcoal, in a pit eighteen inches broad and deep. Though the natives of Dande village, near Boulebane in French West Africa (213), produce most of their iron from a large furnace, they manufacture a superior quality in crucibles, in which the ore is mixed with the charcoal and smelted under a forced draught.

"In 1843 the BaGatla tribe of Bechuana were smelting iron in small crucibles by a very wasteful process in which only the purest lumps of iron were preserved" (61a).

Please notice what different functions the crucible filled in the cases just named. In one it was chiefly a mixing vessel for an alloy; in another, a means of refining crude iron; in others, a means of primary iron smelting. But even for the last purpose its uses vary; for the "Southern Bantu" apparently used it to keep the ore away from the charcoal, whereas the Dande people mixed charcoal and ore within it. When we consider these variations, and the widespread use of crucibles to heat metals for casting and forging, we may feel that the subject is too large and too scantily documented to be of any constructive value.

But at one point it gives us an idea. Though our best descriptions of modern copper-smelting in Katanga do not mention crucibles, Lemaire (152) and Klusemann (142) both believe that Katanga produced some of its copper by the crucible method, since Lemaire has found a crucible in an abandoned furnace with eight flues placed radially beneath it; and that iron was smelted in the same region by this means, just as we have found it to be among the OvaMbo. Klusemann suggests that the use of a crucible for smelting iron may have grown out of this technique for smelting copper. This hints at the priority of copper smelting for at least one area. Before we can consider this theory fairly, we must dispose of the question of fluxes.

The Mumbwa smelters were not the only people in Africa who treated iron with a flux. The finding of auriferous quartz with iron slag at an old mine thirty miles southeast of Francistown in Southern Rhodesia (81) suggests the same technique here. I have already mentioned a flux in copper-smelting among the BaKaonde of the Kasempa district (184) and among natives west of Lake Nyasa (161),[44] as well as by the old copper and tin workers of the Transvaal (240). The proximity of these to each other and to Mumbwa hints that the use of a flux for iron-smelting may have been transferred from the copper-smelting technique.

Wyckaert's (307) account of iron-smelting in Ufipa gives us only the most tantalizing hint of fluxes. This author fails to mention them in his general description of the furnace charge, except to remark that the clay matrix of the ore may have had fluxing powers; but when he tells of a specific case of smelting among Christianized natives, he says that they used fluxes of both limestone and bone! One may suspect in the latter case the influence of the mission's vocational school; but all other parts of the process, except the supernatural ones, seem to have been aboriginal, and I believe that we should add Ufipa to our short list of places where fluxes were known.

Further north, modern natives seem to have employed a flux for welding only, to reduce any oxides which may have formed on the surface; especially the Masai, the Karamoja tribes of Uganda, and the natives of Kiziba. Stuhlmann (261) and Merker (185) state that the Masai sprinkle with pounded mollusc shells the iron to be welded; Rehse that the Kiziba people use for the same purpose a powder made by pounding up an old tuyere. Wayland (296) reports the latter practice from the Karamoja tribes of Uganda, but explains that they first mix the pulverized tuyere with water. The use of vegetable salts in smelting gold, reported by Mungo Park for the Mandingo at Kamalia (200), is a kind of fluxing. But none of these northern examples are strictly relevant to the iron-smelting problem in the southeast.

Reviewing the evidence, we find that our data on the crucible smelting of iron in South Africa are very doubtful; in fact, the OvaMbo are the only group definitely stated to have practised it. For the rest we must accept Lemaire's say-so and the guesses of van Riet Lowe. The refining of iron in crucibles, however, was done by the "Southern Bantu" (300) and WaFipa as well as much farther north in East Africa.

The crucible smelting of copper is only slightly better documented. It was probably performed on the old smelting sites at Blaauwbank, associated with the manufacture of bronze, as well as in Katanga; and the crucibles found in the Mauch Ruins of Zimbabwe and in the old stone huts of Vechtkop may have been used for this purpose.

As for fluxes, we have certain proof of their use in smelting iron at Mumbwa, strong suggestions of the same at Messina (240), in Ufipa (307) and the site near Francistown;

42. 50: p. 117.

43. 4: p. 219.

44. 161: pp. 536-37.

while they are definitely stated to have been employed for copper smelting at the old Transvaal sites, by the modern BaKaonde, and by the people west of Lake Nyasa.

The suggestion of Klusemann and Lemaire that iron metallurgy was influenced by that of copper here in the Southeast is supported by both crucibles and fluxes. We must remember that this was the region where bronze was once made and where copper was cast into fine rods of the marali form; and that both these practices imply a crucible for the secondary melting of the metal. This might have prompted the use of crucibles for smelting. The fluxing technique, however, which had been used to increase the amount of copper obtainable at a single operation, might have been taken over by the Mumbwa smelters in their first attempts at iron, where its mysterious effects may have ruined the iron for any mechanical purpose. The Mumbwa smelters, on the other hand, may have been as skilful at regulating the furnace heat, and at refining or puddling, as the WaFipa apparently are, and thus may have produced wrought iron or steel in spite of their bone flux.

Crucibles and fluxes may seem odd things to treat together, since the former are associated with the production of steel, in which the proportion of carbon must be most carefully controlled; whereas the latter favor the production of cast iron, where the carbon is allowed to play havoc with the metal. But these very facts place the two items in relationship with each other, as sophisticated, special developments; and their concentration in the Southeast, near the ancient mines and smelting sites, supports the idea of strong foreign influence on the metallurgical complex in this area.

VII. TIN

DISTRIBUTION AND MINING

Tin presents a special problem, since only two tin-mining centres have been found in Negro Africa: the Transvaal , and Bauchi Province in Northern Nigeria. Moreover, tin seems never to have been traded into Negro Africa in any great quantity. It had two uses: as a precious metal for making ornaments, and as an ingredient in bronze.

I have already discussed all available data on tin in the Southeast. There are only a few, very indefinite references to the metal between the Transvaal and Northern Nigeria. At Simariango village, near the Longkwe River, a blacksmith told Livingstone (161)[1] that tin was obtained from a people in the north called the Marendi, and that he had made it into bracelets. Livingstone adds that never before had he heard of tin being found in this part of Africa. He saw Manganja women occasionally wearing tin lip plugs, but does not inform us whether the material was traded or locally mined. Such data are hardly sufficient to add Nyasaland to our map of African tin production, but they at least open the question of tin being mined and smelted in this general region.

We must now take a big leap across Central and East Africa, where no tin has been reported, to the grassland belt of the Sudan. Dimashqi, in the Middle Ages, gives us our earliest record of the metal, saying that the natives of Ghana loved tin because of its rarity and valued it more highly than gold (178).[2]

The largest if not the only source of West African tin lies in the neighborhood of the town called Liruen (Riruwei, Liruwei,, in the west of Bauchi Province, Northern Nigeria, about half way between Yakuba and Zaria (254). Near this town an old pit marks the spot where, according to the natives, the former inhabitants mined tin. About seventy-five years ago these miners were expelled by the Ningi and Kano people, who took over the smelting and trading of the metal, while the defeated citizens moved south to found a town called Liruen Dalma. They later regained the northern town, but seem never to have resumed their tin industry there. Apparently the Kano conquerors of the northern Liruen have never mined tin themselves, but procured the ore, in exchange for gold and other merchandize, from the pastoral Fula and the pagan Sangawa in the hills, who collect it from the streambeds, wash it, and bring it to Liruen. There the tin workers pound it in a wooden mortar, mix it with water, and form it into cakes, which may contain as much as 70% of the metal.

Having been smelted and cast, as will be described, the tin straws are clipped to even length and sold in bundles of a hundred, the price of a bundle varying from 1800 to 2000 cowries (between 1s.2½d. and 1s.4d. in British money). This tin is traded over long distances by the Hausa, being sold as far east as the Nile, as far west as Ashanti, Benin (178)[3] and Timbuktu, south to the Baya of the Cameroon (272),[4] and north into Tripoli. To obtain it, traders come to Liruen from Bornu, Ibi, and even the Gold Coast. Bosman in the seventeenth century (308)[5] found the natives on the Guinea Coast casting gold-weights of copper and tin, and the latter might have come from Liruen as well as from Europe. Much Bauchi tin has probably found its way into European hands. That bought by European traders from natives on the Benue was probably a product of the Bauchi furnaces. The bronze tobacco pipes ascribed by Meek (183)[6] to the Jukun may have contained tin from Liruen.

Beads and spirals of this metal have been found between twelve and sixteen feet deep in modern cassiterite workings in Bauchi (138). Stone implements lie scattered on the surface of the ground near the same mines, but nothing indicated their associations with the mines themselves.

These tin objects probably include the disc beads reported by Meek from Lower Bisichi, ten feet deep in alluvium. The same author mentions a coiled tin snake found in a surface deposit at Rop. He says that natives in Bauchi cannot trace tin-working back for more than one hundred years (182).

TIN SMELTING

Tin is by far the easiest of the three metals to prepare, since no flux is needed and no mechanical requirements make hardening necessary. Our only account of modern tin smelting in Africa comes from the Hausa of Liruen (182,254).[7]

The smelting furnace, smaller and crud-

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1. 161: p. 315.
2. 178: p. clxxxviii.
3. 178: p. xlvii.
4. 272: p. 186.
5. 308: pp. 2-3.
6. 183: p. 435.
7. 182: Vol. 1, pp. 151-55.

er than the one for smelting iron, is about two and a half or three feet high, with a conical interior broadening at the bottom. Its outer surface is strengthened by short pieces of dry grass mixed with the clay. At the rear a pipe-like passage gives entrance to the forced draught from the bellows;while immediately opposite it, at the front, a second aperture allows for the discharge of the metal and the cleaning of the furnace. From this aperture a shallow trench leads down a gentle slope into the hole in the ground which receives the molten metal. At the back of the furnace stand two pairs of drum bellows, their long clay spouts converging into the rear opening.

The smelters charge the furnace with charcoal, light it with burning embers, and partially close the front door with stones. Having worked the bellows till the whole contents are aglow, they press fresh charcoal into the top and add the first batch of ore. Staudinger says that the cakes of ore are simply laid on the fire; Trevor, that the ore is "mixed with ground-clinker obtained from a previous smelt," and the mixture moistened with water and "sprinkled on to the fresh charcoal overlying the charge, at intervals of from five to ten minutes, and in amounts varying from half a handful at the commencement to a large double handfull at the end of the operations." Pairs of men take turns at the bellows, working the skins quickly up and down by means of loops attached to their diaphragms, and spelling each other with increasing frequency as the smelting approaches completion.

The molten metal begins to appear at the outlet about two hours after the initial charge of ore. It first solidifies in the little trough, but soon the flow becomes sufficient to trickle into the pit. When the tin ceases to run readily, about twenty minutes after the last charge of ore, the smelters leave the bellows, remove the stones blocking the door, rake out the remains of metal with the clinker, gritty residue, and half-burnt charcoal, and allow the metal remnants to run into the pit.

Now follows a series of precautions against the least loss of tin. The charcoal is returned to the furnace to aid in the next smelting. Women crush the cold clinker and wash it in a stream, leaving prills containing about 60% of tin, which are mixed with a fresh charge of ore for further reduction. While the gritty residue is still hot, the smelters place it in a large calabash and drive off its lighter elements by centrifugal panning; catching the overflow in an earthen vessel, allowing it to cool, and blowing off the still lighter impurities, which they will mix with the fresh ore and concentrated prills for the next furnace charge. To the tin in the catch-pit they add the molten tin remaining in the calabash, keeping the former in a molten state by an overlying layer of burning charcoal. Having cleaned off this charcoal, which, with the dross, they add to the next charge of the furnace, they cool the metal in the pit by splashing water on it, and take it out as a large lump. When several of these lumps have accumulated, they are melted in an earthware basin covered by a fire of charcoal and wood, and cast in a bed of ashes to form the tin "straws."

The noteworthy feature of this process is the extreme economy exercised to recover any tin which is temporarily lost in the slag. When we come to casting, we shall suggest the possibility that the Yoruba derived the cire-perdue process from the Hausa area. Could not the Yoruban use of selected clinker as a flux for smelting iron have been learned from the Hausa tin-smelters? I make bold to suggest this only because these two neighboring peoples seem unique among modern Negroes in their use of slag in a subsequent smelting.

VIII. ALLOYS

BRONZE

After hearing so often of the Benin bronzes, the reader may be disappointed to learn that not a single Negro culture has been known to show proficiency in the manufacture of bronze. Alloys of tin with copper have been made by several groups in West Africa and the Southeast, and a number of archaeological specimens have turned up; but the modern alloys contain copper, tin, lead, and other metals in haphazard proportions, as if the craftsmen had never realized the virtues of combined tin and copper in the standard one-to-nine ratio; while the ancient pieces, which are of somewhat better quality, have so far occurred only where their indigenous origin lies widely open to question.

West Africa

Historical and ethnographic references give us little information. Meek (183) says that the Jukun of Northern Nigeria make bronze tobacco pipes. Since the Yoruba of Southern Nigeria work both copper and tin (262) we may infer that they produce bronze also. Himmelheber (119) informs me that bronze was made in Ashanti from Northern Nigerian tin and Katanga copper, and from there traded to the Baoulé, an offshoot of Ashanti in the hinterland of the Ivory Coast, who make no alloys of their own. Unfortunately we have no analyses of true bronze in West Africa or careful description of its manufacture and uses; in fact, nothing but the most casual mention of the alloy anywhere in this area.

The Southeast

In the far south our historical data are almost as scanty. Jan van de Capelle in 1723 found the natives inland from Delagoa Bay alloying copper with tin to make necklets and bracelets. In 1826, Moffat (19,203) saw an old Muhurutse smith near Malopo, Transvaal, fuse the two metals together. Eleven years later, Louis Trichardt (285) in his Diary reports a native on the Dorps River in the Zoutpansberg making bullets from tin and copper melted together in a crucible. The metallurgy was poor, for the crucible "melted" and an attempt to weld a ramrod with copper ended in failure. But this workman was employed by Trichardt, and the metals were probably not of native manufacture.

The best case for Negro bronze is certain objects found in the Transvaal and among the ruins of the Zimbabwe group, in Southern Rhodesia, where separate specimens of copper and tin provide the strongest argument for bronze having been made on the spot.

Zimbabwe has yielded numerous articles in bronze as well as a few in copper. Caton-Thompson (50)[1] reports copper wire from Test Pit A 3 in the midden deposit at the Acropolis; bronze bangles, wire, bracelets of bronze wire coiled over a grass core, in Stratum 2 at the Maund Ruins; bronze wire bangles in the "sub-cement and pre-building positions" and throughout all later deposits at the site. In the Elliptical Building, Hall found spearheads, ingots, bars, wire, and bangles of bronze or copper (50).[2] MacIver described some slag at Dhlo Dhlo which shows that tin was worked there (50);[3] and Caton-Thompson (50)[4] in the Mauch Ruins found little crucibles with slag still adhering to their interiors, one containing a speck of bronze. The tin probably came from Rooiberg, since no ancient tin workings have been found in Southern Rhodesia. Stanley (246) declares that all the Zimbabwe bronze which has so far been examined shows approximately the ideal ratio of nine parts copper to one of tin, and was apparently made by mixing the previously smelted metals. Caton-Thompson (50),[5] however, says that the tin proportion varies greatly, and suggests that the bronze may have been a natural alloy. The alleged absence of nickel and arsenic in this bronze (246) would probably indicate that it did not come from the old Transvaal smelting sites. Wagner and Gordon (292), however, report a bronze bangle from Zimbabwe which has a small increment of nickel, though no arsenic. The builders of these ruins may have used tin and copper from the Transvaal, but we cannot safely identify them with the old miners, since the ruins show no geographical relation to the mines (284,286).

At the same smelting sites at Rooiberg in the Transvaal, impure and low-grade bronze is more abundant than copper or tin and is probably the metal which the smelters were trying to produce. It occurs as slugs and prills embedded in the slag (249). The largest of these weighed 31.3 grams (67). Since they contain a notable amount of nickel, and bear too low a proportion of tin (less than 3%) and too much arsenic to be classed as true bronze, they may more properly be labelled copper or copper speiss (292). The smelters probably introduced the nickel and arsenic accidentally when they mistook annabergite (nickel arsenate) for malachite,

1. 50: p. 74.
2. 50: p. 92.
3. 50: p. 64.
4. 50: p. 117.
5. 50: p. 65.

both of these minerals having a similar color (292, 67, 246), or may have obtained nickel ore accidentally with copper ore, such as at Pilandsberg near Rustenburg (246). No annabergite appears among the ores brought to the site for smelting, but it may have weathered away. The apparent failure to produce serviceable bronze seems to have been largely due to the uncontrolled proportion of arsenic (19).

Only two or three specimens of good bronze have been found in the Transvaal. Trevor (285) reports a small piece of bronze and a fragment of a tin bangle unearthed at Agatha in the Pietersburg district. One specimen, discovered by Frobenius, was a pellet containing no arsenic but a small amount of nickel (292). Another was the famous "Blaauwbank ingot" (291), which had apparently leaked out of a fissure in a furnace wall or overflowed from a crucible (284), and represents the nearest approach to serviceable bronze found in this area (292). This analyzed: copper 80%, tin 7%, iron and aluminum 5%, nickel 3% — a higher proportion than had any of the prills — arsenic 2%, gangue 3% (19,284,286). The presence of arsenic may be due to non-calcination of the tin concentrate (19). The Blaauwbank farm is one of the few places in South Africa where nickel ores occur (19). No known Transvaal ore would yield such an alloy as the above by the simple process of smelting (284), and, as we have seen, there are no early copper mines in the Rooiberg district.

Several writers (64,76,292) have suggested South Africa as the source for the ancient nickel-bronzes of Mesopotamia, Egypt, and northwestern India. Sebilien (239) and Desch (76) have failed to find nickel-bearing copper ores in ancient workings in the Near East, specifically in Kurdistan, Angora, Persia, Cyprus, Egypt, Sinai, the shores of the Black sea, and Sea of Marmora. Recently, however, an ore very poor in copper (1.0%) but containing about 0.19% of nickel has been found in old workings at Jebel el Ma'adan in Wadi Ahin, inland from Sohar in Oman. The slags near this site show no nickel, so that some must have gone into the smelted copper. The low percentage of copper allows very small claim to this site as a source of the metal in the Near East, but we must withhold judgement till more archaeology has been done in Arabia.

BRASS

General Historical Considerations

Since Negroes seldom or never mined zinc or lead, we may assume European or Arab trade for all brass which we find in Negro Africa. This trade began very early. Historical references to brass, though suggestive, can never be trusted, for the Arabs used the word nahas for copper and bronze as well, and bronze and brass are almost interchangeable in European writings. Nevertheless, a passage in the Periplus of the Erythraean Sea (178),[6] about 75 A.D., mentions "artifically prepared brass" imported for ornaments and as a medium of exchange into the Abyssinian kingdom of Aksum. In the fourth century, a Greek inscription of King 'Aizan of Aksum (178) mentions bronze or brass statues set up to commemorate a victory over the Beja; and Kosmas Indikopleustes in the seventh century says that the natives of Upper Abyssinia value brass more than silver or gold. Though Abyssinia lies outside of the Negro area, such trade probably affected northeastern Negro groups. As Johnston points out, brass was brought to the Niger and Guinea regions by Arabs and Moors as well as by Europeans on the coast; and probably came first into the Central Sudan with the Muslim invasion (134). Its abundant use in the western coastal regions from the Cameroon to Ashanti has made this area famous among collectors.

West Africa

I hope I shall not seem too iconoclastic if I persistently refer to the Benin "bronzes" as brass. The more widely accepted designation has fostered the popular idea that the Benin work stood alone in material and technique. The problem of the origin of cire perdue casting in Africa thus came to be focussed on Benin, whereas actually it concerns a large area in which true bronze, in the strict sense of the word, is exceedingly rare. The alloys made in this area, Benin included, are primarily mixtures of copper, lead, and zinc. Tin was used, just as were lead and zinc, to give a low melting point and a greater hardness, properties desired for ornamental castings (165),[7] but the tin content seldom rises as high as 7%. To judge from the few analyses available, the Benin smiths cared little about the relative proportions of the metals composing the alloy, and placed no special value on the tin (165). Von Luschan informs us (165) that four pieces which were made at the same time, in the same workshop, and by the same craftsmen have a copper content varying between 64% and 98%, a zinc content from nil to 33%, while lead comprised from 1% to 3% of the alloy.

The early sources of these materials in West Africa can only be suggested. Copper, as we have seen, probably came in from the Sahara, though a little may have leaked through from the Katanga and the Southern Congo. In the seventeenth century, tin as well as copper was traded by Europeans to natives on the Gold Coast (65). Some of the tin from the Bauchi mines undoubtedly reached Benin (178).[8] It may, indeed, have been the first metal to be alloyed with copper in West Africa, long before lead and zinc entered through foreign trade. For these two

6. 178: pp. cclxxxiii-cclxxxvi.
7. 165: pp. 22-25, 507-10.
8. 178: p. xlvii.

baser metals we are bound to invoke contact with Europe or the Arab world (133).[9]

Copper and its alloys were always luxury metals in West Africa, where weapons and tools were made of iron (178). In a Portuguese description of Benin in about 1486 (222), we read that a powerful neighboring monarch called the Ogane was accustomed to place brass crosses on the necks of Bini ambassadors who visited him. The Benin brass workers at the time of their greatest achievements were probably using ready-made brass, brought to them both by Europeans on the coast and through trans-Saharan and trans-Sudanic commerce, just as do the Pangwe (269), Yoruba (131), and other West African groups. The presence of arsenic, antimony, and nickel in some of the Benin pieces indicate an Iberian rather than a North European source (165). One large brass manilla, obviously imported into Benin from Europe, shows 20.66% zinc and 2.67% lead, an alloy well suited to cire perdue casting but not for making implements, vessels, or wire (165).[10] In 1505, twelve or fifteen of these manillas were the price of a slave in Gwato, near Benin city (178). Virchow (288), however, notes a brass currency ring from West Africa, of unknown origin, which he believes is not European, because it lacks tin and zinc. It analyzes: copper 68.32%, lead 24.65%, antimony 5.15%, iron and other impurities 1.88%.

Among modern West African tribes, the Edo make ornaments of an alloy of copper and lead as well as working in brass (275), an art which is chiefly practiced in the town of Edo itself (273). Talbot (262) says that the Ibo do practically no brass work, but Basden (15) mentions considerable activity in brass casting by this group. The Munshi are well known for their brass work, though it is somewhat crude. The Bafia of the Middle Cameroon buy their brass from the Jambana (?) who get it indirectly from European trade through Kribi and Jaunde (271). The Pangwe likewise derive all their brass from coastal trade (269).[11] The Agni of the Ivory Coast (266) make their copper ornaments and gold dust weights from brass bought from Europeans. The Baoulé of the Ivory Coast hinterland obtain brass from the coast by way of Tiassale, with lead, salt, and Venetian glass beads, in exchange for gold and ivory (119). Further references to West African brass will be found in the section on casting.

Congo

In the Congo, brass and other alloys of copper were likewise an imported luxury. This is specifically stated for the BaPende, BaKongo, Mosengere (of the Lake Leopold II-Lukenie region) (171), BaTeke, BaNgela (BaLoki), Mfini River people, Mangbetu (134, 62).[12] The BuShongo imported some brass before they had actual contact with Europeans, but it was very precious (282). Brass did not spread evenly and quickly to all Congo tribes. When Sir Harry Johnston wrote, the people on the Mfini River had plenty of brass rods, whereas the Lake Leopold II people had none (134).[13] The BaNgala are one of the few peoples who apparently work brass but not copper. They know the latter metal, calling it dikulu or likulu, but Weeks failed to observe any either worked or worn. Hambly (114) says that the Ovimbundu work brass into bracelets, but does not tell where they get it.

South and East Africa

As yet we have no evidence that the brass and zinc used by the natives of South and East Africa were of local origin, while several facts suggest that all the zinc, if not the brass itself, was imported.

A Kafir tradition (285) relates that about 1820, in Natal, an epidemic called "the sickness of the pigeon" visited the natives, and that their doctors ordered all brass ornaments to be destroyed. To substantiate this, 500 lbs. of broken brass armrings and neck-rings — trade manillas of European make — have been found in the ground on the banks of the Umvolosi, probably the White Umvolosi. This incident suggests that the Natal natives at that time regarded brass as something strange and dangerous; but it corresponds in time and general character with the Kafir ban on tin, rumored by Isaacs (129).

Shooter (241)[14] says that the Kafirs made beads of copper and brass in the old days, and that the natives of Natal obtained their brass through the AmaTongo from the Portuguese at Delagoa Bay, melted it in crucibles of coarse sandstone sunk in glowing charcoal, and ran it into small clay moulds. Champion (54)[15] found the captains at Dingaan's kraal wearing brass collars.

Further north, MaKololo women were wearing brass ornaments at the time of Livingstone's visit (161). The BaNyamwezi obtain their brass from the coast and work it like copper, melting it in a clay crucible, pouring it into a mould of wet sand, and hammering it when cold (256). The WaNyaturu obtain brass as well as copper from the coast (218), but value iron more than either of these metals.

The sources of zinc and lead for South African brasses is as yet undetermined, though European and Arab trade seems probably indicated. A native whose wife was wearing a brass neck-ring showed Trevor a small

9. 133: Vol. 1, p. 75.
10. 165: pp. 507-10.
11. 269: pp. 224-39.
12. 62: Vol. 2, pp. 129-30.
13. 134: Vol. 1, pp. 168.
14. 241: pp. 355-57.
15. 54: Vol. 1, p. 202.

old working where he said the ore for the brass had been extracted, but an examination of the working showed it to have yielded copper but no zinc (285).

One zinc ingot from Pietersburg weighed fourteen pounds. In 1918 a fifteen pound zinc ingot was found in a cave in Tjuenie's Poort; the local chief Mapathelela claimed other objects found in the cave, but had no interest in the zinc, about which he could only say that it had come from the east and was previously used by native smiths (285). The BaVenda obtained lead from the Portuguese and melted it with copper to make an alloy (255).[16] The indications further north point again toward coastal trade. Fülleborn (88) says that brass was probably cast in Ungoni; that lead and zinc were worked by natives in contact with the coast; and that the Portuguese probably taught lead casting, along with gold casting, to the natives on the Lower Shire.

Stanley believes that brasses found near Rooiberg were probably made from zinc derived in medieval or early modern times from Arab or European hands (256). Trevor formerly held this to be true for all South African brass and zinc, but he is beginning to waver. He thought that the zinc ingots said to have been dug up in old kraal sites near the Pilandsberg in Maliesburg district had been imported and used by the Boers for hardening bullets, but he has been unable to find any evidence that they did so.

Adam (2) has reported some ancient workings in the Low country where zinc and copper occur together, and has suggested that this composite ore might have been smelted directly to a kind of brass. He admits that samples of the ore which he examined contained far too much zinc for ordinary brass, but believes that the surface workings may have been much richer in copper. He has found quantities of slag near these workings, but no metal. Mixed copper-zinc ores occur near Nondwani in Zululand and in the Murchison Range in the Transvaal (246).

16. 255: p. 65.

IX. CASTING

Metals may be run directly from the smelting furnace into moulds, or the shapeless bloom or pool may be allowed to cool and then be resmelted for casting. The result may be either currency pieces of conventional size and shape, or more or less finished ornaments or tools.

Casting is rare in East Africa, where it seems to have had an Asiatic derivation and not to have penetrated west of Kilimanjaro (107), but elsewhere it is widely distributed.

OPEN MOULD CASTING

In the most primitive method, the metal is simply poured into an open mould of earth, clay, or stone. This is practised, for example, by the Nupe of Northern Nigeria (182),[1] using moulds of the last named material; and by the Bambara (309), using a mould of sun-dried brick with the cavity well lubricated with shea butter. In a crucible made of clay mixed with charcoal and chopped straw, the Bambara melt imported European copper by burning pounded charcoal over it with a forced draught till the crucible becomes red hot. They then pour it into the mould, let it cool, and fashion it by pounding, filing, and twisting, reheating it several times during this process. Having given the ornament its final form, they again heat it, and soak it in a mixture of water, salt, and brew from the tamarisk fruit; then wash it in clean water and polish it with earth. The Mayombe (196)[2] likewise cast in clay moulds. The people of Fouta (84) make a sort of gold filigree by pouring molten gold on a finely grooved slab of very hard wood. Van den Plas (210)[3] mentions open-mould casting for the Kuku, but give no description.

Tessmann's description (271)[4] of tin- and brass-casting among the Bafia of the Middle Cameroon is a bit vague, but apparently denotes an open mould technique. He says that the mould is cut either out of the ground or out of a piece of raphia pith and the molten metal poured into it from the crucible. He reports the same from the Pangwe (269),[5] who pour the molten brass into a hollow of the desired form cut in the pith of a raphia stalk which has been split lengthwise. When their casting has set, they clean it of charcoal, plunge it in water, and finish it by reheating, hammering, filing, and engraving.

The natives of the Lake Leopold II-Lukenie region, in the Belgian Congo, melt trade brass in small crucibles of refractory clay and pour it into cavities made in the sand. The small bars thus formed are then polished by filing, and the filings given to the head artisan as his fee (171). The BaKongo smiths, northwest of Manianga above the Congo cataracts, cast copper ingots about four inches long and three inches wide, standardized for purposes of trade (134);[6] while the Bushongo cast copper in sand to form bracelets and other ornaments (282).[7] Hambly states that the Ovimbundu of Angola (114)[8] make brass bracelets; and though he says nothing of their method, we may assume that it is the same. A hybrid technique is practised by the BaPende in the Belgian Congo, who make brass castings of wooden and ivory masks by impressing the masks in clay and using the impression as a mould (283).[9]

But our best accounts of open-mould casting come from the Katanga, on the borders of Northern Rhodesia and the Belgian Congo (116). Here the BaYeke reserve the refining and casting of the copper for the rainy season and for professional coppersmiths. The latter employ a furnace similar to that used for smelting, but unplastered and smaller — about forty centimetres high and twenty-five in diameter — and with only a single pair of bellows. The crucible — a pot about twenty centimetres deep from which the neck has been broken, carefully lined with finely ground wood-ash — sits embedded in the charcoal on the bottom of the furnace. Within the charcoal near the top the smiths place about five kilograms of copper which they have beaten into small pieces. It takes about half an hour of firing, under constant draught from the bellows, to melt the copper sufficiently for it to run down into the crucible. Having demolished the furnace, the master smelter, protecting his hands with wet pads of cloth, pours the molten copper from the crucible into a mould cut from termite earth, which has been coated with wood ash and thoroughly dried in the fire. This should never be done in full sunlight lest bubbles form in the copper. The ingot weighs between two and three kilograms. Copper anvils, too large to be made in termite earth, are cast in the ground.

The BaSanga of the same district cast copper in a furnace similar to their smelting furnace in material and pattern and in

1. 182: Vol. 1, p. 156.
2. 196: pp. 195 ff.
3. 210: pp. 181-84.
4. 271: p. 149.
5. 269: p. 238.
6. 134: Vol. 2, p. 805.
7. 282: pp. 193-96.
8. 114: pp. 158-61.
9. 283: p. 350.

the number of bellows used, with a bowl-shaped bottom rimmed with beaten wood ashes. From the outlet a channel led into a cruciform ash-lined clay mould, large enough to cast a cross weighing 12, 15, or 50 kilograms. A man could carry two of the smallest crosses at a time; but it took two men to carry one of the largest, on a long stick. Formerly a large cross was the price of a female slave, while a male cost a little less.

Ladame (150) did not observe the casting process in Katanga, and doubts the account he received there. The natives told him that they placed a clay crucible on a pile of termite hills, set a piece of copper over it, and covered all with charcoal, which they burned under a forced draught. An aperture in the crucible, closed during the smelting, was finally reopened, and the copper flowed down a gutter into moulds dug in the ground.

Arnot (10) says that at one place in Garenganze, in the same area, "the copper is cast in the form of a capital H, and the angles of this figure are perfect. At other mines it is cast in the form of a Maltese cross, the mould being made in the sand by the workers with their fingers; and out of twenty casts from such moulds scarcely a fourth or an eighth of an inch difference is discernible." Livingstone noted these currency pieces at Casembe in 1871 (219).

At Lupanda, near the sources of the Lomami and Luembe Rivers, Cameron (46) in the 1870's found X-shaped pieces of copper currency which had been smelted and cast about fifty miles to the south. They were considerably smaller than those described above, for they were carried in loads of about twenty, ten or so being slung at each end of a pole. On the plains between the Ugoma Mountains and the Lukuga River, just west of Lake Tanganyika (46), he again saw similar currency pieces weighing between two and one-half and two pounds each, the diagonal measurements of the X being from fifteen to sixteen inches, the arms about two inches wide and half an inch thick, often with a raised midrib. These were in great demand among the Nanyema to the northwest of this location. He states that they came from Urua, which we may identify as the district just north of the Katanga.

Casting in an open cavity in clay, cowdung, or earth, to make flat or X-shaped ingots has likewise been reported from Natal (Zulu-Kafir) (241),[10] the Nama Hottentot under Bantu influence (230),[11] and perhaps from the Banyamwezi, and a stone mould found at the Rooiberg smelting site suggests that this was an old method.

Gardiner (33)[12] in 1839 described the Zulu melting of "brass" in a crucible made of a very refractory sandstone, sunk to its depth in an open charcoal fire blown by bag bellows of the ordinary South African type. He says that this "brass" was either "run into bars for forming throat rings and armlets, or into smaller clay moulds for the knobs and studs" with which the women adorn their costumes.

The simplicity of the methods outlined above, and their wide and discontinuous occurrence, allow us to draw no historical inferences. Two other casting techniques, however, stand out as high-lights in the picture of Negro metallurgy, not only for their more specialized character but for their archaeological context and their concentration in the two areas most significant in foreign trade. These are rod-casting and the <u>cire perdue</u>.

ROD CASTING

The copper ingots most commonly found as heirlooms and archaeological pieces in the Transvaal and in the eastern parts of Rhodesia were cast in holes bored in sand or earth, or in reeds thrust into the ground. This method seems to have a limited and continuous distribution in the Transvaal and northward as far as Tanganyika. All of the resulting pieces examined by Stanley show no corrosion and are apparently recent.

Three small ingots shaped like an inverted top-hat with a number of peg-like excrescences on the bottom have been found in or near the Limpopo River (286) and attributed to the BaKwena (258, 284).[13] Stanley (246) suggests that these are probably "heads" left over from the casting of long rods which had been broken away. They have cores of stone or sand, which would provide sufficient weight to force the copper into the moulds and would at the same time economize on metal.

One, found near some old copper workings in the Transvaal, was figured by Stow (258) as probably "a mandula or phallic charm." There is certainly nothing phallic about it. Stow thought that it had been "made in three castings:" the "pegs" and the adjacent part of the crown, the main mass of the crown, and "brim of the hat." There are more than twenty "pegs," and the marginal ones lean slightly outwards, as they would if representing the series of tabular moulds in the ground, for which the ingot was the casting head.

Similar but roughly rectangular ingots with studs around the outer edge are treasured as sacred heirlooms by a few Venda chiefs and by certain BaLemba (255),[14] who associate them with the ancestors and sometimes worked them into charms. The BaVenda

10. 241: pp. 355-57.
11. 230: pp. 315-16.
12. 33: Vol. 1, p. 305.
13. 258: p. 518.
14. 255: pp. 66-68.

call them musuku — the Lemba word for copper and all copper objects. Stayt suggests that the BaVenda formerly used them as a medium of exchange.

The "marali" copper ingots (109), shaped like a long-stemmed tobacco-pipe with pegs on the bottom of the "bowl," represent the same method. About a hundred of these have been collected (286). The conical head of the ingot is the cast of the depression through which the molten copper was poured into a set of reeds covered with earth or into holes thrust in the ground (109), while the peg-like or root-like shorter projections are the stumps of the other rods made in the same casting and broken off. Most marali are somewhat hollow. Either the smiths knew how to pour out the molten copper from the inside after the exterior had solidified, or the hollowness was caused by contraction on cooling (286). These light bars, as we shall see, may be originally associated with wire-drawing, since they lend themselves readily to the drawplate (232).

Though marali are no longer made, and are greatly treasured by the Transvaal natives as family heirlooms (109) — one marali having the value of several cows — we find several historical and ethnographical references to the technique which they represent. Apparently they have been produced fairly recently by BaPedi workmen (286, 284) and by the BaLemba (232). Junod (136) describes the copper currency ("lirale") made by the natives of this region as "sticks about 1 1/2 feet in length, 1/2 inch in breadth, finished off by a semi-circular head." Lindblom (159) believes that the BaLemba cast their copper currency bars in the form indicated by the marali ingots; and Schlömann (232) in 1894 wrote as if these ingots were then still procured by the BaLemba, who attributed them to the Zimbabwe district north of the Limpopo.

Junod (136) says of the BaLemba: "Having remained in touch with their kinsmen who were dwelling in iron or copper districts, especially in the BaVenda mountains, they bought from them the raw material which they had worked in their various houses. The copper was sold to them by the miners under the form of sticks called 'ritsondjolo,' and they transformed these sticks into a fine wire to make bracelets." This last remark, together with Schlömann's statement that the BaLemba attributed marali to the Zimbabwe district, suggests a nice continuity with the old Zimbabwe culture; for, as we shall see in our section on wire-drawing, precisely the type of spiralled wire bracelets made recently by the BaLemba, BaVenda and a few others, were unearthed in the famous ruins.

But rod casting has spread some distance beyond the Lemba-Zimbabwe center. Holden (122),[15] quoting Moffat, says that the "Baroutsie" copper-smiths cast "brass" — a mixture of tin and copper melted together in a crucible — by pouring it into holes made with a stick in damp sand. Gardiner in 1839 (33)[16] reports this method from the Zulu, in addition to their casting in small moulds. W. H. Brown (177) in the latter part of the nineteenth century saw a Karanga smith at Mashayangombe's kraal melting brass cartridge cases and pouring the metal into a mould which he had formed by thrusting a stick into the ground and lining the hole with wood ash. The bar thus obtained was beaten into bangles for women's ankles and wrists. Stuhlmann (261) says that the natives of Tabora and elsewhere in Tanganyika melt Katanga copper in small crucibles and cast it in bamboo stalks or in holes made in the earth. Stern (256) describes a similar process among the BaNyamwezi of this area, who heat the Katanga ingots, chop them into pieces of convenient size for the crucible, and mould copper arm-rings in the earth, finishing them cold. His remarks, however, may refer to casting in ring-shaped open cavities.

The tin-workers at Liruen in Southern Nigeria (254) use a similar method, though they have probably developed it independently. They make their moulds by pressing earth or damp ashes around a number of reeds, about fourteen inches long and a twelfth of an inch thick, set parallel and at a gentle slope. When the bed has dried sufficiently, they withdraw the reeds and ladle the molten tin by a calabash into a shallow trough of ashes above the moulds, which acts as a distributing channel. The tin "staws" thus cast are clipped to equal length for purposes of trade.

The BaNgala (298), in addition to the cire perdue process later to be described, cast brass in a split bamboo stalk from which the pith has been removed, clean and polish the bar thus formed, and wind it around the leg as an ornament. This may show independent invention, but it is probably to be connected with the casting technique of the Baya and Pangwe to the north.

CIRE PERDUE

The origin of cire perdue casting in West Africa has been the subject of numerous little discussions, and though I am not in a position of offer any new evidence I may be able to clear away some of the confusion. Writers have almost invariably brought artistic issues into the question, have seen very little beyond Benin, and have too often felt called upon to champion the cause of Negro genius, or to disillusion their readers in this regard. Their historical deductions, too, have been far from well grounded. Thus the native tradition that a white man called Ahammangiwa lived at the court of King Esiga of Benin, did metal casting for the

15. 122: pp. 241-48.

16. 33: Vol. 1, p. 305.

king, and taught the natives the art (165)[17] fails to convince us of foreign introduction, since he might only have been enlarging and improving an indigenous technique. The statement that the Benin castings are "thoroughly African in style," even if true, has very little to do with the question. But let us look beyond Benin and see what we find.

In modern times the cire perdue has been reported from as far east as the Shilluk (121),[18] and from as far south as the BaNgala of the Upper Congo (297), both of whom make the model of vegetable materials rather than of wax: the Shilluk of the resin of the Ficus sycamora, the BaNgala of plantain root. The natives of Dyerma in French West Africa (208) also make it of vegetable gum. For both the Suk (24)[19] and the Lango (82)[20] we have moulds mentioned, but, unfortunately, not described. Hafmayr's report (121) of cire perdue casting among the Shilluk suggests the same for these other two Nilotic groups; and a ring, probably of iron, found by Leakey (155)[21] in doubtful association with a doubtful Neolithic burial in the Eburru district of Kenya Colony, and lost by him before it could be studied, may well have been made by this process.

The process centers, however, in tropical West Africa, between Northern Nigeria and Ashanti, and as far north as the Big Bend of the Niger. In this general area it has been recorded for the following tribes and localities: Fouta (84), Tiong-ti town near Tengrela (32),[22] Dyerma (208), the Samo of Yatenga (264),[23] Habbé (78),[24] Mossi (174), Ashanti (215),[25] Togo (253), Baoulé (165),[26] the Gold Coast (165), Yoruba (262),[27] Benin (164, 178), Edo (275), the Bagam area of Central Cameroon (172), Munshi (182),[28] Jukun (183),[29] Hausa (253, 182, 178).[30]

The Baoulé, says Himmelheber (119), have no other form of casting than the cire perdue, a statement which would probably hold true for most of West Africa. He observed the process especially in Kokumbo village, famous for its gold. Few Baoulé learn the art, for there is no large current market for objects so precious and indestructible as these castings. They cast bronze and brass commonly, copper and gold somewhat rarely, tin and iron very seldom; importing all these metals except gold.

To avoid the danger of fire, the caster's workshop, like that of the smith, stands on the outskirts of the village; a plain, gabled roof resting on posts and without walls. A clay wall about twenty centimetres high encircles the hearth, leaving an aperture for the bellows tuyere. Nearby, also surrounded by a clay wall, lies a pit of soft sand to hold the mould while cooling. The artisan works his wax with a small, flat piece of wood held in his hand, and a smooth wooden board about sixty centimetres long and five centimetres broad, notched at one end and resting on two sticks set in the ground. These sticks are respectively twenty-five and thirty centimetres high and thus give the board a slight slope from end to end. He also uses a pair of jointed tongs, an iron knife, a wooden knife for incising and forming the wax, a flat pottery vessel, and a flat half-melon shell on which he sticks the model while fashioning it.

He prepares the wax very carefully; presses the honey out of it, boils it to let the dirt sink free, and wrings it dry in a cloth. When it has cooled sufficiently to be worked without breaking, he dampens it and works it soft between his fingers. The wax for the finer parts of the model he spins into a thread by rolling it between the two smooth boards, and winds it into fine spirals. For hollow objects he makes an inner clay core, leaving, by means of a clay projection, a small hole through which this core may be broken and picked out; but he makes his solid castings from a simple model of wax.

When he has finished his model, he prepares the material for the mould by pulverizing clay and wood ashes together between a pebble and a flat stone, sprinkling water on this mixture to make a thick black paste, and thinning this paste with more water till it has attained just the right degree of fluidity. Having smeared this on the wax model with a chicken feather, he places the model on a leaf to dry for one day, gives it another coat of the same mixture, and repeats the process again on the third day, bringing the thickness of the clay coating to about two and a half milimetres. After another day of drying, he heats the mould and allows the wax to run out through a hole which he has left through the clay by means of a wax extension. He then strengthens the mould by increasing its thickness with a centimetre or two of clay mixed with fibres which have been left over from pressing palm-kernal oil. To ensure a safe casting, he leaves it for ten days on a leaf in the sun, for the interior of the mould must be absolutely dry.

He now makes and dries in the sun a clay crucible, several milimetres thick and about as large as the mould. Having filled this with his metal, he inverts it over the mouth of the mould, lutes both vessels together with a thick clay coating, and bores a hole at the point of junction to set free the gases which will form under heat.

17. 165: Vol. 1, pp. 22-23
18. 121: pp. 320-21.
19. 24: p. 18.
20. 82: pp. 86 ff.
21. 155: pp. 97-98.
22. 32: Vol. 1, p. 191.
23. 264: pp. 577-78.
24. 78: pp. 368-69.
25. 215: pp. 309-16.
26. 165: p. 512.
27. 262: Vol. 3, pp. 923-28.
28. 182: Vol. 1, pp. 155-56.
29. 183: p. 435.
30. 182: Vol. 1, pp. 149-57; 178: p. xlvii.

Two hours later the new clay joint is dry enough for the casting. The artisan catches the mould with his tongs and places it in the fire with the crucible downward, and blows the fire to its greatest heat with the bellows. When the noise through the hole tells him that the metal has melted, he reverses the mould and sets it in the sand to cool. After an hour of cooling he pours water over it and breaks the clay away.

Occasionally the Baoulé cast gold-dust weights and other small ornamental articles directly on locusts or other natural forms.

Bowditch in 1819 (33)[31] described a similar technique of gold-casting in Ashanti, from which the Baoulé had migrated a century before; adding that the Ashanti gold work could not equal that of the Dagwumba people — presumably the Dagomba of the Ashanti hinterland. The beeswax, he says, is "spun out on a smooth block of wood, by the side of the fire, on which stands a pot of water; a flat stick is dipped into this, with which the wax is made of a proper softness." The model made of this wax is enclosed in a composition of wet clay and charcoal, which is dried in the sun. To this mould is attached a cup composed of the same mixture, from which a small perforation leads to the model. "When the whole model is finished, and the gold carefully enclosed in the cup, it is put in a charcoal fire with the cup undermost. When the gold is supposed to be fused, the cup is turned uppermost, that it may run into the place of the melted wax; when cool the clay is broken, and if the article is not perfect it goes through the whole process again.... To give the gold its proper color, they put a layer of finely ground red ochre (which they call inchuma) all over it, and immerse it in boiling water mixed with the same substance and a little salt, after it has boiled half an hour, it is taken out and thoroughly cleansed."

We have good accounts of cire perdue casting from the Edo of Southern Nigeria and from the Bagam district of the Cameroon.

Let us take the former example first (275). Edo has sadly declined within the last few generations, so that the only good objects made nowadays are hawk-bells, bracelets, brass hilts for knives, and brass masks to be worn by chiefs when visiting the king. Boy apprentices first learn to fashion the moulds for small bells by rolling a fine cord of wax, mixed with oil, on a camwood roller and board, and winding this around a clay core to give the desired external pattern, with a final curl for the handle. Thomas' description of the next stage of the process is not at all clear; we may assume that the model is covered with clay, leaving a hole for the passage of the wax. A number of these moulds are then placed in a large pot, arranged like grapes on a bunch, with stems of wax leading through the clay matrix to each model. When the pot is heated the wax runs out, and the brass, having been melted in a sand-tempered clay crucible embedded in the fire, is poured into the moulds. The latter are then plunged into water, the clay broken away, the bells filed smooth and polished with sand.

Brass casting in Cameroon (172) centers at present in the neighborhood of Bamum and Bagam towns in southern Adamawa. The smiths make their models of beeswax which they have refined and worked into thin sheets. For hollow objects they form a core of clay mixed with grass, over which they spread the wax. Having prepared the model, they work soft clay around it, forming at the top a cup-shaped vessel with a hole leading to the top of the model. They dry this mould in the sun, and harden it in the fire under a continuous gentle heat maintained by the bellows. After pouring out the melted wax, they place small pieces of brass in the cup at the top of the mould, cover them with a cap of clay, and coat the whole mould with a thick clay layer. This they then place in the fire with the cup uppermost and blow the fire to the greatest possible heat, occasionally taking the mould out to add more clay to its exterior. After about two hours of firing, they allow the mould to cool and break away the clay from the finished casting. This method gives more time for the molten brass to run into the mould than if it had been poured in, and minimizes the danger of bubbles and other flaws (165).[32] The smiths provide for the escape of gases from the mould by leaving a small hole or by mixing grass with the clay, so that the mould will be porous when the grass has burnt out (165).[33] The fuel for the fire is usually charcoal, sometimes the kernels of Canarium Schweinfurthii. The Egap tribe of this district specialize in the production of pipe-bowls, ornaments, and grotesque animals and birds. They make bells for sale to other tribes but not for their own use. Bamum town specializes in brass flasks.

The Mossi (174) melt copper and zinc in crucibles and cast the resulting brass by the cire perdue process, using boiling water to melt out the wax.

The Yoruba living in German Togoland have a nice technique for casting heads from an alloy of copper, zinc, and lead (11). They make the basic model of clay, leaving it hollow to allow a rate of cooling uniform with that of the outside clay mould. This suggests the technical trick of the old Benin craftsmen, who left hollow the round or half-round parts of the casting, apparently not to save brass or wax but to give uniform cooling (165). Having made the basic model, the Yoruba pour melted wax over it, fitting

31. 38: pp. 311-12.

32. 165: p. 16.

33. 165: Vol. 1, pp. 15-16.

the wax closely and adding the details by appliqué. They enclose this finished model in a thick layer of clay, leaving a hole through which the wax runs out and drips into water when the mould is heated. They then turn the mould in the fire till it is red hot, when they pour in the molten metal. Most defects arise from gas bubbles or an over-rapid cooling which leaves gaps in the casting.

The technique demonstrated by a Hausa smith of Kete Kratschi, in Togo (253), closely resembles those described above. After heating the beeswax, modelling the figure in the rough with his fingers and a small, smooth stick, he adds the details by applying separate pieces of wax. He covers the model with clay, leaving an aperture for emptying and refilling, and several smaller holes for the escape of air, and dries the mould for three days in the sun. He then heats the mould, pours the wax out, sets the mould on the ground, and pours the molten brass into it from the crucible. When it has cooled, he breaks away the clay, soaks the brass for several days in lemon juice, and files the rough places smooth.

Meek states that the Jukun (183),[34] who make bronze tobacco pipes by the cire perdue method, have learned this technique recently from the Hausa, who use it in the manufacture of iron swords. Robinson reports the casting of iron swords in Kano (178).[35] This seems a most unreasonable way to make a weapon which is frequently subjected to shock and stress, and we could afford to doubt the statement if Meek did not know this area so well and give so circumstantial an account of the process. He says (182):[36] "The cire perdue method was commonly employed by the Hausa and some of the more advanced pagan tribes. For the manufacture of swords and other articles models in beeswax were first made. These were covered over with clay, leaving a small aperture. The wax was then melted out and the clay casing was baked hard. Into this the molten iron was poured, and when it cooled the clay was broken off, leaving the finished article." Since Negroes as well as Mediterranean peoples make their swords of wrought rather than cast iron, we may assume that the Hausa transferred this technique from gold and copper to iron, a material scarcely suited to it.

Himmelheber (119) informs me that the Baoulé in the hinterland of the Ivory Coast cast iron by the cire perdue, but that the results are crude and unpleasing.

The BaNgala show interesting modifications of cire perdue casting. Having cut a plantain root into the shape of a leg ring, they enclose it in clay, leaving a small hole. They then bake the mould till the root burns to powder, which they shake out through the hole to make room for the molten brass. When the casting has cooled they break away the mould, scrape the brass ring smooth, and incise it with herringbone and lozenge patterns (297). Their technique of casting in a split bamboo stalk may be somewhat older, and related to the Bafia and Pangwe techniques. The presence of these two methods here is especially interesting, in view of the fact that the BaNgala work brass but not copper. Since their brass must be a relatively late importation, and since they probably have never cast iron, both methods would seem to be recent — the bar casting a local invention or imported from the east or south, the cire perdue derived from the north and west.

Though we have not enough data to indicate the early home of cire perdue casting in West Africa, we may draw a few hints from the material at hand. They seem to point clearly to the north.

In the first place, it is most likely that the process was first applied to gold or copper or one of the copper alloys. As we have seen, the richest gold fields lay in the interior of the Western Sudan; and though possibly a little copper trickled through from the far Katanga, most of the copper or brass used on the Guinea Coast before the European trade must have come from over the Sahara. This suggests, at the outset, a northern origin for the cire perdue.

Tradition agrees. The chief of Bamum town, in Central Cameroon (172), says that brass casting was brought by an invading race from the northeast; and the tribes north and west of Bamum explain that they learned it from this town. This hints at a Hausa connection, to which we shall refer in a moment.

The Ashanti probably derived the art from the north rather than from the east, for they were surpassed in it by the Dagomba (38), and their work is stylistically different from that of Yoruba and Benin. The close stylistic relationships between Benin and Yoruba casting may be due merely to contact within the last few centuries, but, on the other hand, it may suggest a Yoruba derivation, for the art is especially an affair of the Benin royalty, who claim descent from Yoruba (165).[37]

Beyond Yoruba, the track leads to the Hausa, who seem to have been especially responsible for the spread of the art. A Muslim member of the Hausa colony in Kete-Kratschi district in Togo, who claimed that he came from an old family in Ilorin, said that his family and those who had married into them had held the secrets of cire perdue casting for many generations (253). The Jukun, as we have seen (183),[38] apparently

34. 183: p. 435.
35. 178: p. xlvii.
36. 182: Vol. 1, p. 155.
37. 165: Vol. 1, pp. 510-12.
38. 183: p. 435.

learned the technique recently from the Hausa.

Balfour (12) has described a related art, though he fails to recognize its significance in connection with the cire perdue. This is the tandu process, by which the Hausa mould vessels of animal membrane around a clay core, breaking out the core when the membrane, at first very adhesive, has dried sufficiently to preserve its desired form. The Hausa have exported these vessels to the Gold Coast, Dahomey, Togo, Cameroon, and to the Tuareg. The Tuareg prize them highly because of their resistance to the rough-and tumble of caravans and raids, and even make them for themselves. The Hausa examples resemble the local pottery forms in almost every particular, even in style of decoration. A vessel similarly made was unearthed at Thebes from the 19th to 22nd Dynasties, and I saw one brought into Siwah Oasis by a caravan from Kufra, its interior still reeking with rancid butter. Balfour cites several references to the same technique among the Southeastern Bantu, particularly the Zulu-Xosa group, for making animal dolls and snuff-boxes; and traces it as far afield as Northern India and Afghanistan. But its special development among the Hausa argues for their old acquaintance with a similar process for shaping objects of metal.

Just a word about antiquity. As for the technique in Benin, von Luschan (178, 165)[39] offers one argument for its introduction before the coastal trade. He says that the Benin natives would have imported brass ornaments and implements from the Europeans, rather than brass in the crude form of manillas, had they been ignorant of the cire perdue at the time of the earliest European contact. These manillas, he points out, were of an alloy especially suitable for this form of casting, and not for wiredrawing or the making of tools or weapons. The Portuguese and Dutch traders at Benin may have been only satisfying an old demand for castable metals rather than creating a new market.

Rattray (215)[40] believes that "the art of casting in brass and bronze did not reach a high state of development until after the foundation of the Ashanti kingdom about two hundred years ago." The Ashanti, however, must have been casting by cire perdue at that time, since the Baoulé, an offshoot who then migrated westward to the hinterland of the Ivory Coast, duplicate the Ashanti castings in details of style and technique.

One is tempted to believe that the golden ornaments in the medieval courts of Ghana and Malli, described so covetously by contemporary Arab writers, were cast by the cire perdue. Apparently the oldest known objects thus manufactured in West Africa have been discovered in tumuli in the Goundam district, on the Niger just southwest of its big bend, where Desplagnes found small animal figures of copper (77, 178).[41] The date of the tumuli can only be surmised as approximately the tenth or eleventh centuries, in the heyday of Ghana. Stylistically the figurines resemble those cast on the Gold and Ivory Coasts at the present time, and it seems very unlikely that they were turned out by any other method than the cire perdue. Their association with Neolithic celts and with elaborate pottery of a kind wholly unfamiliar to modern natives of the district might allow a somewhat greater antiquity than the tenth century. Native traditions ascribe the tumuli to an ancient people called the Killi, and Desplagnes, in his elaborate and ill-considered theory of migrations around the middle and upper Niger, says that metal-working and cire perdue casting were brought to the Niger banks by the "Red" Soninke.

Thus the leads all take us northwards to the Western and Central Sudan; the former an area rich in alluvial gold, for which it has been exploited for centuries; the latter peopled by a race of artisans and traders who, early converted to Islam, have been the chief middlemen between the caravans of the Sahara and the Negro kingdoms of the south. Two ultimate interpretations suggest themselves at once. The cire perdue was either brought to the coast by the Hausa and similar peoples, who had got it from Mediterranean cultures through long-distance trade; or it was invented in the gold fields of the West African interior, at first only for making gold ornaments, later for casting copper, brass, and possibly iron. I suggest a compromise. North African trade has been focussed for centuries on West African gold; and the Negroes at the point of focus have had ample opportunity to learn the cire perdue technique from their cultural superiors, who came to them for the primary purpose of taking the gold away. But its presence among the Nilotic tribes, with their relatively simple arts and their minimum of foreign contacts, still waits to be explained. To the solution of this little problem there leads only one path — the untrodden one of Negro archaeology.

39. 178: pp. xlvii ff.; 165: pp. 507-10.

40. 215: p. 310.

41. 178: p. clxxx.

X. THE TECHNIQUE AND EQUIPMENT OF THE FORGE

After the spectacular achievements of iron-smelting, the humbler work of the blacksmith at his forge seems comparatively uninteresting, and has consequently been neglected by many observers who give us fair descriptions of smelting. This is a great pity, for tempering and welding, as well as the repeated heating and hammering of the nascent blade, bring to completion the effort which began at the mine, and it is only in them that we can study the ultimate purposes of native metallurgy. I therefore offer the following notes mainly as a plea for more data.

Stone anvils prevail everywhere for the rougher stages of work, and throughout East and South Africa seem to be used even for finishing. Those of the AKikuyu and Labwor, specialized in quite different ways for the production of a midrib on spears and swords, are unique in our records, and correlate with the very high development of iron-forging in this region, especially among the AKikuyu.

The iron anvils which we may generally designate as "nail-shaped" — though their thickest portion may be near the middle and the upper end be cylindrical — are more at home in West Africa and the central forest than in the east and south. Their most interesting aspect is their analogy to the straight, unhafted iron hammers. The latter have a wider distribution, occurring not only in these areas but in many places and tribes in the east, specifically Masai, Usindja, Bukoba, WaDumbo, Wadoe, Labwor, BaNyankole, WaRundi, Ruanda, and among the BaIla in the south. This form of hammer may be stuck into wood or the ground and used as an anvil for finer work, as it is by the Pangwe, the WaRundi, the Lake Leopold II -Lukenie tribes, and probably in Bukoba. The BaMbala use their T-shaped iron hammer in the same way. It seems very likely, therefore, that these forms of anvil and hammer were originally a single instrument. The Lake Leopold II-Lukenie tribes now ritualize the distinction by allowing only the master smith to use an iron anvil as a hammer.

The practice of setting the iron anvil in a log or wooden block seems typical of West Africa and the Congo, not of the east and south. Its farthest recorded extension northeastward is the "Jur," where the anvil is simply a rough piece of iron driven into a palm trunk which is sunk in the ground; its southernmost, the Ovambo, where the anvil is wedge-shaped. These forms, which seem less specialized for the setting in wood than are the nail-shaped iron anvils prevalent over most of Central and West Africa, may be "marginal" degenerations, though one naturally hesitates to apply a Dixon-Wissler methodology when the distributional data are so meagre.

The straight, unhafted iron hammer is often worked as a pestle with a stamping motion, in which the nose of the hammer does the work. This explains the essential difference in shape between the two ends, such as among the Labwor, who use the round end for surface finishing and the flat end for finishing edges; and among the BaIla, where one end of the tool is blunt for hammering and the other is chisel-shaped for cutting. Often, however, the Negro smith holds his unhafted hammer as we hold our hafted one. Some of the hammers are nicely specialized for this technique, having an angular cross section or sharply divided facets, so that a flat or a ridged surface may be brought down on the hot iron by a simple turn of the wrist.

Some tribes use socketed iron hammers hafted to a short wooden handle. In the southeast this seems to be a recent modification due to European contact; but it may be early in the northeast, as among the WaChagga and AKikuyu, and perhaps among the Ababua, Mangbetu, and Bongo of the northeastern Congo borderlands, as well as in Dyerma and the Western Sudan generally. Routledge describes this usage among the AKikuyu (227):[1] "When the smith picks up his hammer for use he holds it in such a way that the handle and the head both lie in the same horizontal plane. The convex bevelled face that terminates the long arm rests on the work; all the rest of the hammer-head lies to the right-hand side of it. The smith then raises his hand by a few inches to a higher level than the work, but still maintains the handle parallel with and to the right-hand side of it. He tightens his grasp of the slight round handle, and simultaneously rotates his wrist outwards. The hammer-head thereby passes from a horizontal to a nearly vertical position. He then relaxes his grip, whereupon the slight handle rotates in his grasp, as the long arm of the hammer-head falls from the vertical to strike, with its bevelled extremity, the appointed spot. At the same time, from the wrist, or from the elbow, according to the force of the blow required, a flicking movement is conveyed to the tool, similar to that employed to crack a hunting-whip." Only for the hea-

1. 227: p. 90.

viest work does the Kikuyu smith swing his hammer from his shoulder.

Metal tongs take two forms: jointed, in which the two jaws are hinged together by a bolt; and one-piece pincers, a bent strip of iron, often having its two arms brought together by an iron ring which slides over them, thus tightening the grip on the object being held. The former, seemingly more sophisticated kind, has a wide distribution: Liberia, Akpafu (Togo), BaSonge, Mandja, AKikuyu, Masai, Nandi, and probably in many

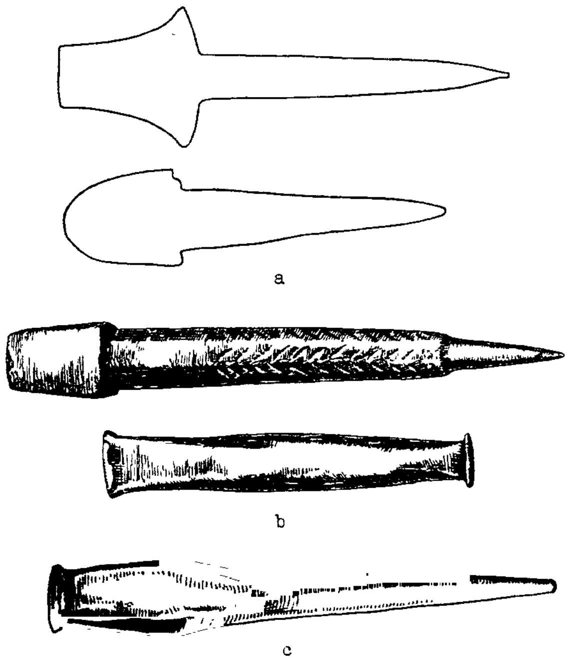


Fig. 9. Hammers. a, Lake Leopold II-Lukenie region; b, Eastern Congo; c, Bukoba.

localities where the form is not described. In spite of what the AKikiuyu told Routledge, I cannot believe that these jointed tongs are ultimately indigenous. Rivets, nails, and the like do not fit the pattern of Negro handicrafts, where wooden and metal objects are almost invariably made in one piece. The special elaboration of the Kikuyu tongs, however, correlates with the high development of anvils, wire-drawing, and chain-making in this exceptional culture, and suggest a northeastern derivation for most of Kikuyu metallurgy.

The single-piece pincers occur among the Ovimbundu, BaChokwe, and in Ondulu, thus hinting at an Angolan distribution. It would be interesting to find that this was the early Portuguese form. The BaNyamwezi, however, apparently use both the one-piece and jointed tongs.

A more rudimentary holder, a split green stick, seems especially in use in East Africa, but turns up also in the Cameroon. Forcing the hot iron into a temporary wooden handle is the most primitive substitute for tongs; while the hollow cone in which the Lake Leopold II-Lukenie tribes manipulate the hot iron is a very special development, along with the rest of their elaborate equipment for iron-working.

Welding is reported from the AKikuyu, Jur, Bongo, Masai, people of Kiziba, WaChuka, Labwor, BaKonde, BaLuba, and possibly from an old Rhodesian mine, and therefore is apparently an eastern trait. It seems best developed among the Labwor, the Masai, and in Kiziba; the Labwor sprinkling the iron with mud made from pulverized old tuyeres, the last two groups using powdered

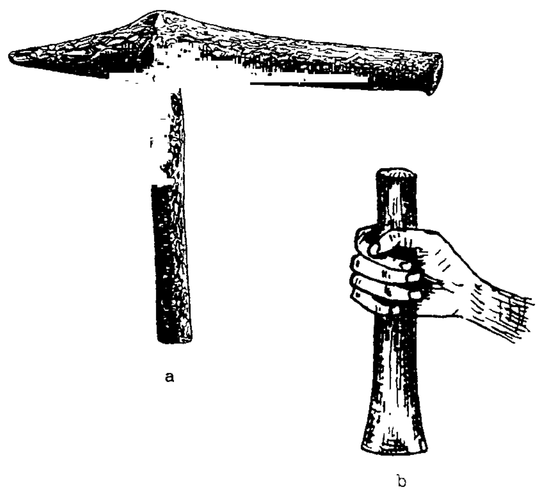


Fig. 10. Hammers. a, AKikuyu; b, Masai (a, redrawn from 227; b, after 185).

snail shells in the same way, so that the silica can reduce any oxides which may have formed on the surface. The same purpose may be served by the powdered stone which the WaRundi sprinkle on their anvil "to prevent the cooling of the object being fashioned."

In view of the fact that tempering implies steel rather than wrought iron, the references to this process observed in the foregoing material have special significance. Unfortunately I have found no statements as to the degree or careful regulation of tempering and cannot interpret the practice, recorded in several cases, of quenching the hot bloom on its withdrawal from the furnace. This is one of the points which might be cleared up by a laboratory study of Negro iron objects in our museums.

The following table briefly presents the above information, as well as a general view of forging practices which need no further discussion. For convenience I have placed the hard wood anvil of the BaNgala in the column for stone anvils, and have included a few remarks on copper-working for comparison with the working of iron.

Comparative Table

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
Moors of Senegambia (31: pp. 118-19)						Tempering: several layers of powdered charcoal and pieces of iron; covered with clay; heated; iron taken out and plunged in water
Western Sudan (9)	Iron: double pointed stuck in piece of wood; or nail-shaped stuck in ground		Block-shaped, with tang; hafted in stout wood haft	Chisels and files of steely iron. Small clay crucibles		Crucibles
Liberia (101:pp.56-57)	Stone: smooth		Pointed	Tongs jointed		
Tiong-ti, near Tengrela (32: Vol.1,p.191)	Iron: stuck in wood block		Unhafted bar	Pincers. Coarse files. Small unhafted chisels		
Dyerma (208)			Hafted; like the Kikuyu form but short end is cylindrical at tip			
Senufo (71:Vol.1, pp.263-66)	Stone: granite		Bar	Awls		Beat slag out of iron, plunge it into cold water
Banfora (92)	Stone: large, for making pigs. Iron: cylindro-conical, driven into a log sunk in the ground; 5 cm. diam. on upper face					
Mossi (174:Vol.9, pp.718-19)			Cylindrical			Crucible for copper and zinc

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
BaHurutse (122:pp.241-48)			Hafted by hole in center			Broken pots as crucibles for copper
Mashona (268)			Block of iron hafted to wooden handle by hole in iron; this recent	Bark tongs		
Kaffir (122:pp.241-48)				Crude tongs		
Ovambu (154)	Iron: wedge-shaped set in wood					
Katanga (BaYeke) (116)						Crucible for copper, carefully coated with finely ground wood-ash; placed on bottom of furnace surrounded by charcoal
BaYeke For copper: (116)	Stone: large		Copper; grooved to hold twist of bark by which it is wielded	No tongs; pliant piece of bark	Pile of charcoal	
Lamba (80:pp.347-51)					Small hut	
BaIla (242: Vol. 1, pp. 211-21)	Stone: large; embedded in ground	Large hammer sometimes used as anvil	One end blunt for hammering, the other chisel-shaped for cutting; hafted by hole in center; sometimes used as anvil		Roughly built shelter	Axe tempered; spear and hoe not tempered lest they break
BaKoande (184: p.159)			Large, 2 kinds for fashioning implements, etc.			
Old Rhodesian mine (246)						Welding(?)

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
Southeastern Bantu (245)		Large: for use in both hands; unhafted; to break up mass of iron	Modern European hafted hammer for fashioning			Many reheatings during forging
Southeastern Bantu (300)						Crucible for iron
Lokele (243: p.15)			Wedge-shaped;hafted into stick handle			
BaSonge (198:pp.223 ff.)	Iron: short, straight top above widening in end of long, stake-like lower part		Unhafted mass,flaring slightly at striking end	Tongs jointed	Low shed	
BaNgongo (282:pp.193-96)	Iron: nail-shaped, stuck in ground		Straight, constricted at one end for handle; striking end tapering			
BaMbala (Northern) (283: p. 350)	Iron: T-shaped; all one piece; top flat; stuck in ground;also used as hammer		T-shaped, all one piece; top flat; also used as anvil			
BuShongo (282:pp.193-96)	Iron: nail-shaped		Leaf-shaped	No tongs		Inlaying of copper in iron
Ovimbundu (114:pp.158-61)	Stone: tall enough for worker to stand upright		Some large,some small	Tongs clamped by sliding metal ring. Iron sheath holder for axe while it is being hammered hot	Thatched low eaves, square pit	
Ondulu, Angola (206)	Stone: large, fixed. Iron: small, nail-shaped, stuck in log		Sledge-hammer conical with a straight,short handle, projecting from flat end in long axis of cone. Sledge hammer, straight, unhafted	Pincers clamped by sliding ring; jaws widen apart just above ends	Hut built over a stone selected as the large anvil	
BaChokwe (130:p.45)	Iron:conical; point stuck in wooden block		Maul-shaped	Tongs: ring clasp		

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
BaLuba (58:pp.223-25)			Small, for fine work			Welding: cover two pieces with clay, heat, hammer
Chuka (195:pp.129-31)			Large and small	Wooden socket for holding iron while being worked	Small pit with three stones	Neat welding
WaSandawe (75:pp. 108-109)					Wall-less shed	
WaRangi (261)			Hafted			
Wadoe (260:p.37)	Iron: rare		Straight, unhafted	Fire-hook		
Safwa (145:Vol. 1, pp. 180-82)		Large, bored for hafting				Finished implement polished with sand and termite earth
Lumeji River source (46: p. 385)			Hafted			
BaHolo-holo (233: pp. 117-18)	Stone: granite block		Lump	Tongs: wooden		
BaNyamwezi (34:Vol. 1, pp. 161-65)		Long stone of even proportions; double handle of fibre bound to it; thrusting motion. Hand hammer a conical stone bound in fork-shaped stick	Conical, grasped at small end	Tweezers: also jointed tongs		No tempering
BaNyamwezi (central or western) (256)		Large; to beat iron free of slag. Also stone	For making spears and smaller implements	Tongs: large		Iron beaten to shape red hot

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
		hammer for making large implements				
WaDumbo (260: p.558)			Long, no handle	Chisel for cutting barbs in iron arrowheads		
WaKinga (97: pp.166)	Stone: large block of gneiss					
Ruanda (62:Vol. 1, pp.155-58;Vol.3, pls. 12,13,14)			Straight, unhafted, handle round in cross section, head X-shaped in cross-section	Tongs:pieces of wood or hot iron forced into wood. Small bush for sprinkling coals with water	Crude shelter, shallow pit	
Bugurura village, Bugando district, Usindja (260: p.679)	Iron: small, for beating iron to make it compact and free of charcoal		Straight: rectangular cross section, narrow at end	Long iron poker curved at end		
Upper Ogowe (73)	Stone: black like agate			Tongs: iron or wood	Conical pit	Iron sharpened and polished with charcoal and sand;brightened by mixture of palm oil and heated charcoal applied to surface
BaNgala (298: p.89)	Hard wood		Bar; 8-10 inches long, 1¼ inch square	No tongs; wood handle to hold hot iron,slipping on and off		Steel
Lake Leopold II-Lukenie region (171)	Stone: large block of limonite for crude work, set in ground. Iron: local variations, all more or less nail-shaped; set in ground or wood		Local variations, more or less nail-shaped; often used as anvil; sharp end for perforations; incised striking surface	Tongs: wood. Hollow iron cone for handling hot iron; apex of cone inserted in end of long wooden handle. Tempered iron punch. Whetstone	Open shelter	Finished implement

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
Manyara village (46:pp.257-58)		Large, 2 loops of rope as handle	Small		Smithy a small open shed	
Labwor (296)	Stone:wedge-shaped, used to produce a ridged blade	Large;flat or wedge-shaped,latter to produce a ridged blade	Blunt, round point at one end,square at other; pointed end for surface finishing, square end for edge finishing	Tongs: cleft stick	Hut;hollow in floor	Old tools repaired by welding, with quenching and mud flux
BaKitara (223:pp.217-25)	Stone:set in ground	Always worked in vertical position	One-piece,T-shaped, head double ended, 4 in. long;handle 6 in. long			
BaNyankole (225: pp.105-107)	Stone: large		6-8 in. long;round tapering slightly for hand-grip	Tongs: some; but hot iron usually held by being forced into a piece of wood or between split pieces of wood bound together	Shallow hole	Quench newly made hot hammer in water to harden it
Bukoba (261)			Widest in middle, tapering toward both ends; lower end pointed, upper end flattened; striking facets between middle and upper end			
WaRundi (43: pp.51-52)	Iron: sometimes the hammer is stuck in the ground as anvil		One end pointed; serves as anvil when stuck in ground	No tongs;wet stick. Iron file with wood handle. Large "nail" around which iron can be hammered to form hollow objects	Wall-less hut; pit	Anvil sprinkled with ground stone to prevent cooling of object being fashioned
BaNyamwezi (central or western) (256)		Large; to beat iron free of slag. Also stone hammer for marking large implements	For making spears and smaller implements	Tongs:large		Iron beaten to shape red hot

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
WaDumbo (260:p.558)			Long, no handle	Chisel for cutting barbs in iron arrowheads		
WaKinga (97:pp.166 ff.)	Stone: large block of gneiss					
Chuka (195:pp.129-31)			Large and small	Wooden socket for holding iron while being worked	Small pit with three stones	Neat welding
WaSandawe (75:pp.108-109)					Wall-less shed	
WaRangi (261)			Hafted			
WaDoe (260:p.37)	Iron: rare		Straight, unhafted	Fire-hook		
Safwa (145: Vol. 1, pp.180-82)		Large, bored for hafting				Finished implement polished with sand and ter-mite earth
Ufipa (307)	Stone:large,flat		Hafted	Tongs		
WaNyaturu (218:pp.58-59)						
Issansu (218:p.84)				Chisel	Shelter without walls	
WaMakua (261)				Tongs:split green stick		
BaKonde (97: p.172)						Barb weld-ed on to spear-head
Nyasaland (251)				Pliers. Files		Crucible for cop-per and brass
Nyasa-Ruvuma region (97: p. 172)			Large	Tongs or a split green stick		

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
Wangoni (261)			Hafted			
East Africa (261)						No copper inlaying
AKikuyu (227:pp. 79-97)	Stone: 2 grooved anvils for spears, 2 for swords. Granite, oblong, made by specialist. Upper surface smooth and convex; crossed by single V-groove for making midribs; grooved slightly different for swords and spears		3 sizes: straight, rounded, tapering at 1 end; widest part 1/3 of length from this end, bored half through for wooden peg handle; other end long and cylindrical	Tongs 15. in. long, jointed by a well-burred pin; jaws 4 in. long, proximal portion bowed; noses flattened inside; end of each handle pointed for enlarging holes; this form declared aboriginal		Welded by simple heating and hammering. Spear burnished with ball of soft granite
Masai						Before welding, sprinkle iron with pounded snail shells
Masai (185: pp.110-14)			Pestle-shaped; striking end compressed laterally. Stamping motion	Tongs: jointed; long handles, short jaws	Wall-less hut	Iron wire heated, sprinkled with powdered snail shells and welded together for tools, etc.
WaChagga (107)	Stone: lava stone from river bed		Large and small; wood handle in hole in head; head 15-20 cm. long	Tongs: long and narrow		
Nandi (124:pp.36-38)				Jointed cold chisel		
Kiziba (261)						Before welding, sprinkle iron with pounded clay tuyeres

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
Momfu (Nssoba village (260)			Rectangular			
Lugwari (181:p.467)		For first beating, a plain stone	Small, for finishing			
Kuku (210:pp.181-84)		Not shaped		Tongs: split stick		
A-Lur (260:p.527)			Flat on under side, not hafted	Tongs: split stick	Conical, sun-shelter; hearth surrounded with flat stones	Hot iron quenched (tempering?)
Bongo (237:Vol. 1, p.277 ff.)	Stone: gneiss or granite	Large unhafted, for beating small pieces of iron together. Smaller hafted	Hafted	Tongs: split green wood. Chisel		Small pieces of iron reheated in clay crucible
BaNyamwezi (34: Vol. 1, pp. 161-65)		Long stone of even proportions; double handle of fibre bound to it; thrusting motion. Hand hammer a conical stone bound in fork-shaped stick	Conical, grasped at small end	Tweezers; also jointed tongs		No tempering
Fan (French Congo) (139:pp.323-24)	Iron: large; pointed at lower end; upper end tapering; embedded in ground		Solid cone, point elongated for grip	Pointed iron punch for making patterns in iron		
Bagam (173)			Like a lead worker's dresser	Chisel	Open shed	Raw iron placed in rope ring on anvil and beaten

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
						up; then worked into 4 by 6 inch blocks
Baya (211)	Stone: large. Iron: stuck in tree trunk		Block			
M'baka (212)		Hafted	Hafted			Eyed needles made
Pangwe (269:pp.224-39)			1. Large, nail-shaped, one-end sharp and other cuboidal; serves as anvil for finer work. 2. Smaller, chisel-shaped	Tongs: split cardamon stalk. Chisel with wooden handle. Grasping-iron, wooden-handle, held against hot iron till it sticks. File. Cardamon stalk for sprinkling coals with water		Clay crucible for melting trade brass wire; surrounded with charcoal
Mandja (100:pp.225-32)	Stone: large flat, usually leptynite or granite		Not hafted; bar 20-25 cm. long; pointed or bevelled; used as hammer, stamp, or punch	Tongs: jointed; rivet at one-third length	Windbreak pit	Hot hammering only no tempering. Sharpening on flat stone
Ababua (111: p.233 ff.)	Iron: cylindrical or square block sunk in wood or ground and roughened		Wood handle; another kind cylindrical, without handle, 30 cm. long	Graving tool		Blades cooled in water; knife polished with sand and water and then an herb
Ababua (134: Vol. 2, p. 80)			Cylindrical or quadrangular			
Mangbetu (199:pp.265-71)	Iron: prismatic; 20-25 cm. high, 7-8 cm. broad at base, stuck in floor		Small; not hafted; or hafted in forked piece of wood held by withes.			No tempering; iron purified and harden-

Comparative Table (cont'd)

Tribe or place	Anvil	Stone hammer	Iron hammer	Tongs and other instruments	Forge	Processes
			Mangbetu the only tribe in this region using iron hammer			ed by long beating; polished by rubbing on anvil, then by rubbing with sand and banana fibres
Mangbetu (134)	Iron: large, nail-shaped, set in ground	Gneiss, very primitive				
Mangbetu (236)				Files of sandstone or gneiss		No tempering
Mangbetu (62: Vol.2, pp.120-30)			Hafted, for fine work			
Jur (61)	Iron: rough piece of iron driven into palm trunk which is sunk in ground	Plain stone dropped on iron first to flatten it	Not hafted		In hut to prevent sun from shining	Pieces of iron softened together in a teacup-sized crucible
Akpafu (214)	Stone: elliptical, very hard, set in floor		Spatulate	Tongs: large, jointed	Hut with clay wall	
Ibo (15:pp.171-76)	Iron: round, nail-shaped, driven into wood block set in ground		10-12 in. long, 1½ in. diam.			
Edo (275)	Iron: "A stout iron pin with a circular top"		For brass: like a tent-peg, flat side for striking. For iron: conical or square	Fire-hook. File. Chisel		
Yoruba (26)	Stone: large, smooth stone for heavy work. Iron: smaller		Lozenge-shaped cross-section so as to expose a flat side or a ridge by turn of wrist			
Hausa (267:pp.207-15)						Solder (lead)

XI. BELLOWS

THE TWO TYPES

Though smelters may dispense with an artificial draught, the finer operation of forging in an open fire always requires one. To produce a continuous air current, bellows are usually worked in pairs or multiple sets, one being raised as another is lowered. Negroes use two kinds, the "drum" and the "bag," which differ fundamentally and have remained structurally distinct.

The drum type consists of a loose diaphragm fitted over a solid chamber. Through a flue leading from this chamber the air is inhaled as the diaphragm is lifted, exhaled as it is depressed. Since this bellows generally has no valve, its outlet is usually furnished with a funnel-shaped tuyere to prevent fire and heated air from being drawn into the chamber. The spout of the bellows is inserted far enough into the broad end of the tuyere to direct the blast straight to the fire, but not far enough to prevent the intake of fresh air when the diaphragm is raised.

The other type of bellows is a voluminous sack, the broad upper end of which is opened to receive the cool air, then closed and pushed down, driving the air through a solid nozzle at the lower end. This form also usually has a tuyere, though the latter is here less essential.

These two kinds of bellows show a significant relative distribution. The bag bellows, at home in India, Southern Arabia, the Horn of Africa, and the Sahara, has taken a limited hold among Negro artisans. We find it throughout South Africa from the Zambezi to the Cape. It seems to have penetrated East Africa as far as Lake Bangweulu, but not to have replaced the drum bellows to any great extent in the interior. The Shilluk use it, but the Nilotes to the south of them prefer the drum type. The Masai, WaNyamwezi, and WaNgoni use both kinds. In West Africa the bag bellows turns up again, especially on the Upper Niger and the Senegal, and as far southeast as the Jaunde in Cameroon. We thus find it, as we should expect, among leather-working, pastoral tribes, or in areas most open to influences from the Horn of Africa, Berber lands, or Indian Ocean trade.

Throughout the Congo drainage system, in the Lakes Region, and on the West Coast from the Cameroons to the Gambia — in fact, throughout most of the Negro area — drum bellows prevail. They may well have preceded the bag type wherever the latter is found, though this would be hard to demonstrate for the East and South.

Reche (218) gives a good instance of the diffusion of the two types. He says that the WanIssansu use only bag bellows, and their neighbors the WanIramba only drum bellows, because the latter group formerly traded actively with the WaKimbu and WaNyamwezi in the south, who have only the drum type, whereas the WanIssansu traded mainly with the people in the northeast and east, who use the bag type, which has apparently been introduced to them from the Hamitic peoples of Northeast Africa.

BAG BELLOWS

Bag bellows admit few variations. The material of the bag is always skin, usually that of sheep or goat, made soft by greasing and rubbing. While some tribes, such as the Akikuyu (227), WaChuka, and the BaLuba and BaLenje of the Mumbwa District in Northern Rhodesia (169), cut and sew the skin into a long cone, many use it in nearly the form in which it comes from the animal, often binding the nozzle into one of the legs. The bellows-boy opens and closes the bag by means of two loops on opposite edges of the large open end, one for the thumb and another for a finger or two, which he separates and brings together as he spreads and closes his hand. This operation may be further facilitated by two wooden slats sewn to the edge of the bellows below the loops. Very rarely — as among the BaLuba and BaLenje (169, 116) — the bag is permanently closed at the top so that all air must be taken in through the nozzle. In Ufipa each bag is a separate unit, one bag working on each side of the forge (307).

DRUM BELLOWS

More complex in structure, the drum bellows show all degrees of skill and ingenuity, and vary from one area to another in significant ways. The solid chamber, for example, may be either of wood or of sun-dried clay. Clay chambers occur mainly in the Central Sudan, along the Ubangi drainage system and in the adjoining area around Lake Victoria. In the central and western part of this belt and as far north as Darfur, some tribes use wooden chambers; as do sometimes the Ababua, Mangbetu, and BaGanda. The most westerly point where we have recorded clay-chambered bellows is at Banfora, near the head of the Black Volta; the most easterly, Uganda; the most northerly, Lake Chad.

At present they are rare in the central and southern Congo. The people at Ondulu, in Angola, say that they were the old traditional type (217), and Maes (171) believes the same for the BaLesa and other tribes of the

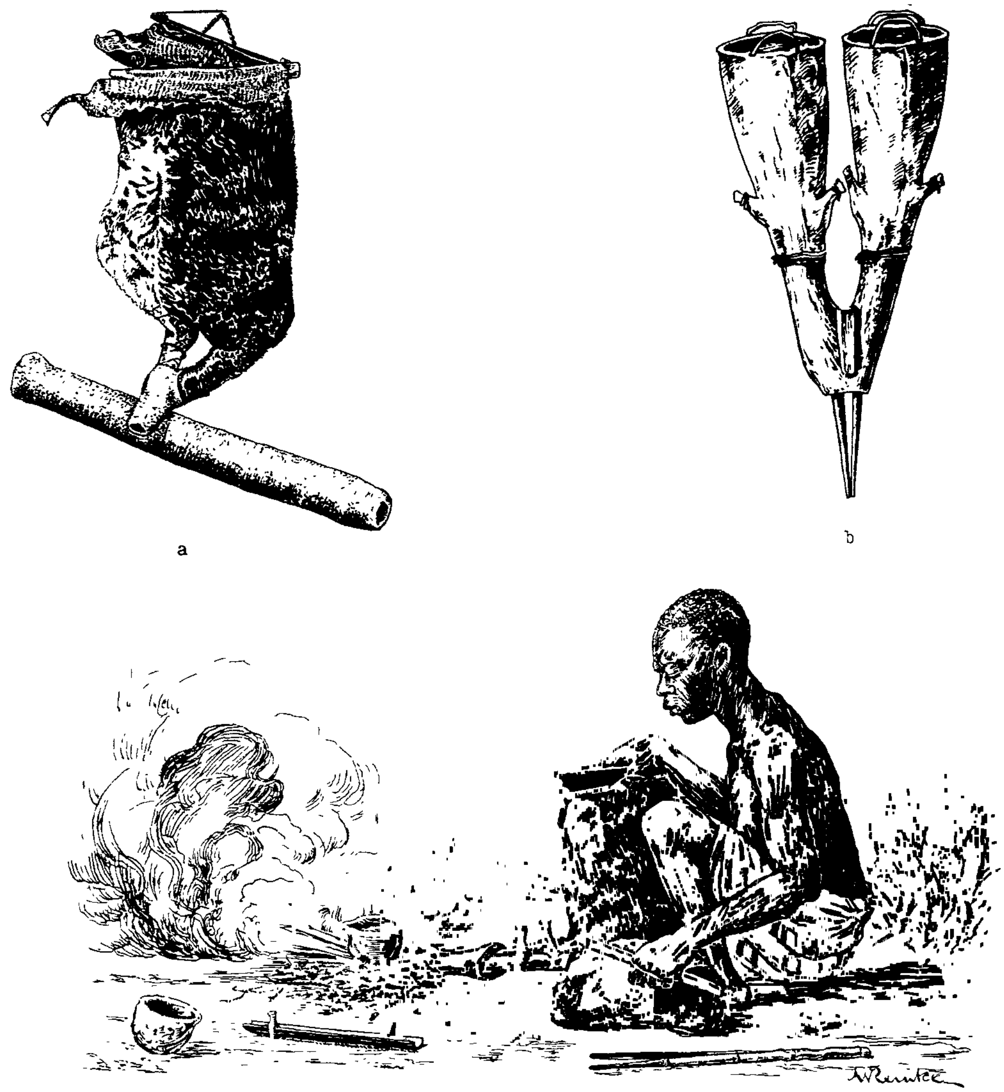


Fig. 11. Bag bellows. a, Angoni (?); b, Western Sudan; c, Angoni: using the bag bellows (a, redrawn after 164; b, after 9; c, redrawn after 305, pl. 20).

Lake Leopold II-Lukenie region. Though they usually make their beautiful composite bellows of wood, the latter groups — specifically the BaLesa, Mosengere, BaSakata, Ipanga, and BaTitu — sometimes form them of clay mixed with banana fibres. In this case the body of the bellows is massive and stationary, adhering to the soil on which it has been fashioned and dried.

Three other instances of stationary clay bellows have been recorded: from the Habbe of the Central Nigerian Plateau (78),[1] Tiong-ti town near Tengrela (probably Bambara) (32),[2] and the Labwor of Uganda (296). They are all different. The first, which we know only from a very sketchy drawing by Desplagnes, seems to be two broad, spreading clay chambers set on the ground, with bag bellows mounted on them; the second, a large wooden compartment covered with clay, on which were luted two old cooking pots with sheepskin diaphragms; the third, a clay wall with the drum bellows protruding from the top. All these variants are used for forging rather than smelting.

Each chamber may be fashioned from a separate piece of wood or clay, or the two chambers may form a structural unit. The ta-

1. 78: plate 85.

2. 32: Vol. 1, p. 191.

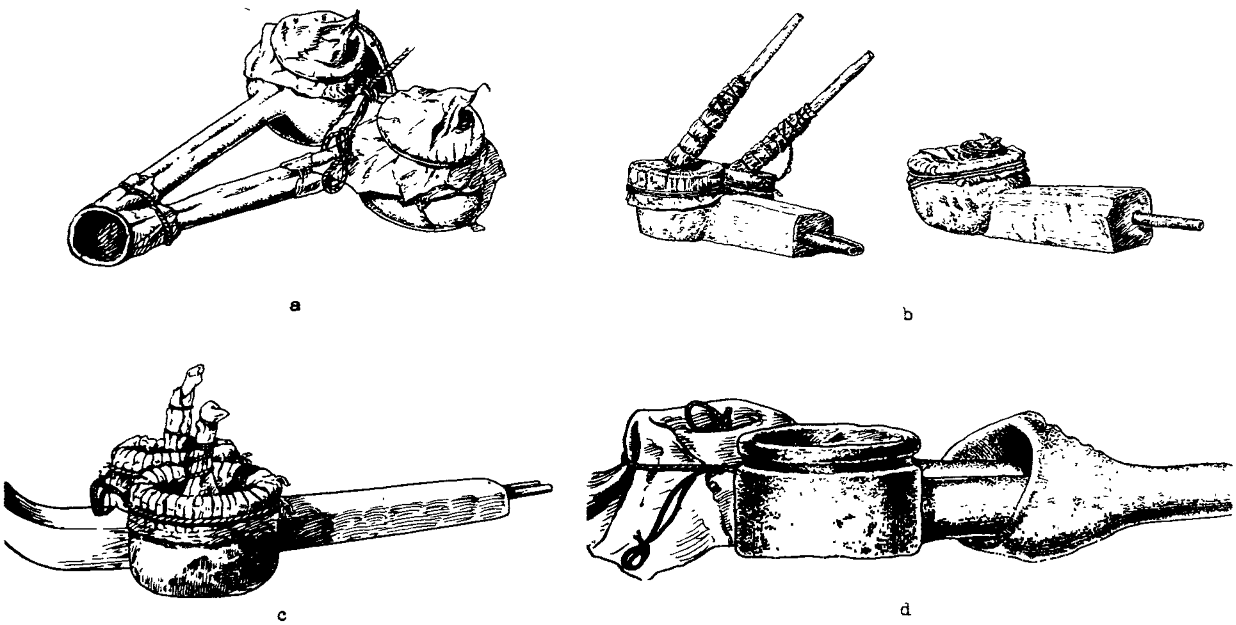


Fig. 12. Drum bellows. a, Chamba (Adomawa); b, Bakundu and Ngolo, Cameroon; c, Bakwiri; d, Jur (a and c, after 164; d, after 61).

ble at the end of this section gives the distribution of the two types. It seems to have little significance, whether from a geographical point of view or with relation to the material of which the chambers are made, but a wooden prototype for the composite form may be suggested.

The tribes in the region of Lake Leopold II and the Lukenie seem unique in their possession of the beautiful multiple chambered bellows cut from a single piece of wood. Some of these have as many as eight chambers, each with its own flue and tuyere, and among the BaLesa at Kulumbuma, in the Tolo district, a single piece five metres long with fourteen chambers has been recorded. The tribes studied by Maes (171) in the Lake Leopold II-Lukenie region prefer the double-chambered type, while the four-chambered bellows have as yet been found only among the Akela (283),[3] BaSakata, BaFumungu, Tumba, BaLesa, Bokala, BaNkutu, and BaSongomeno (?). The BaFumungu at Bomu village, among whom Maes found only a single example of the four-chambered bellows, assured him that this type formerly prevailed throughout the whole region. The specimen which he examined was a very old one, treasured by the chief of Bomu, and was smaller and with shorter sticks than the bellows of the same type now used around Lake Leopold II. Maes believes that this small form with short sticks is of northern origin, and that it indicates a southward migration of the tribes in question.

A number of tribes in the tropical forests use strips of palm-leaf or banana leaf soaked and worked pliable and sewn together (199)[4] instead of skin for the diaphragm of the bellows: notably those of Liberia (133),[5] of the Cameroon at the bend of the coast (175),[6] the Jaunde (269),[7] the Mangbetu (199, 62), the peoples at the headwaters of the Ubangi drainage system, and the Akela (283),[8] Lokele (243),[9] Mosengere, BaSakata, and BaLesa of the Central Congo (171). The Manyema on the Upper Lualaba use grasscloth (46);[10] the Momfu, banana bast (260).[11] This choice of vegetable materials is hard to explain, since the product seems less air-tight and less durable than a diaphragm of skin; but it may be due to the greater resistance of leaf to tropical rains, or to an industrial pattern which favors the use of vegetable rather than animal products.

Drum bellows are usually worked by two sticks attached to the centers of the diaphrams. Some tribes in the northeast, however, employ skin loops for this purpose; notably the Jur (61) and the Karamoja tribes of Uganda (296), the latter sometimes working the bellows with their feet. This may be a transference from the bag bellows form. The lack of any handle for the diaphragm seems to be confined to the central north,

3. 283: p. 195.
4. 199: pp. 265-71.
5. 133: Vol. 2, p. 1020.
6. 175: pp. 113 ff.
7. 269: pp. 229-31.
8. 283: p. 195.
9. 243: p. 15.
10. 46: pp. 257-58.
11. 260: pp. 484-86.

being definitely stated for the Pangwe (269), Chamba (Adamawa) (164), and Namchi (Adamawa) (164); but it may also characterize the Momfu (261), Alur (261), Marghi (261), and the tribes of Karagwe and Urundi (261).

In intermediate regions we often find the same tribe using several variants of the drum bellows. The Mangbetu, for example, may make the bellows chamber either of clay or of wood, its diaphragm of leaf or skin (62, 134);[12] while Ruanda has both the single-chambered and double-chambered body (62).[13]

Two widely separated people, the Lobi of French West Africa (52) and the Angoni of Nyasaland (97)[14] elevate the drum bellows on clay pedestals to facilitate work while standing.

From the Fan of the French Congo, Mary Kingsley (139)[15] described a bellows with a rather elaborate scheme for the intake of air. Her observations do not ring very true, but I give them for what they are worth. Both chambers of the bellows were cut from a single piece of wood, covered with skin from which the hair had been removed, and worked by short sticks; and were lashed to stakes so that the mouth lay just inside the broad end of the clay tuyere, to give free play of air. So far this is the normal arrangement for the central and northern Congo, though Kingsley remarks that the spout of the bellows was not bifurcated as it is among the other iron-working tribes of the neighboring coast, but formed a single prolongation; and that the bellows was decorated with "spear-head forms" with their points directed toward the fire, which were believed to help the draught in a magical way. But "half way up the cylinder there are burnt from the outside into the air passages three series of holes, one series on the upper surface, and a series at each side. This ingenious arrangement gives a constant current of air up from the nozzle."

An interesting variant of the drum bellows is that which has an aperture in the diaphragm to act as a valve, the hand closing the aperture on the downward push and uncovering it on the pull upward. Its peripheral distribution in the northeast and north, as well as its mechanical principle, suggest that it is a hybrid form derived from both the open bag bellows and the closed drum. It occurs in the following groups: Mombuttu (after Schweinfurth), Masai (after Merker), Bongo ? (after Schweinfurth ?), Kordofan (after Russeger), Durru of Adamawa (after Passarge), Bulendjidda, Batta, Dama, Lauka, Kano (after Passarge), Nandi (261;[16] after Hollis, 124),[17] Darfur ? (after Russeger, 229).

One form of bellows used at Dar es Salam and on the neighboring coast (147) looks as sophisticated as its location would lead us to expect. Each chamber is a tube of skin sewn at each end to a wooden disc, and is worked up and down with a stick. The stick is not fastened directly to the top disc, but to a skin flap which, when the stick is lowered, covers a small hole in the center of the disc, and when it is raised leaves this hole open for a new breath. Natives in the same area also use the triangular bag bellows of the ordinary East African type, confirming the impression that the valved form is a later invention or importation.

Fig. 13. Valve-drum bellows: Nandi (after 124).

The bag bellows mounted on a branching pair of clay chambers, described and figured by Archinard for the Western Sudan (9), seems to represent another combination of bag and drum.

CONCERTINA BELLOWS

A third type of bellows, probably also a hybrid form, may be called the "concertina." This resembles the double-bodied drum bellows except for the greater size of the body and the voluminous skin, which encloses a stack of large rings which are drawn apart and allowed to fall together as the bellows is raised and lowered. Stuhlmann (261)[18] locates this type in Northern Togo ('Anima, Kabure, Tamberma, Losso, Tome, Basari), Northern Dahomey (Sugu), Yoruba, among the Grunssi, and Liberia, where Buttikofer's description suggests a variation: the bellows apparently mounted on a board and provided with a flap valve. Our best account comes from Akpafu in Southern Togo (214), but we have good photographs from Tome and Basari (164). The details seem to vary considerably within Togoland. A clue to the origin of this type may be observed in Ashanti, and probably in adjoining coastal regions, where we find the European form of bellows with an accordion-like bag expanded and collapsed between two boards. This suggests that the concertina bellows is a hybrid modification of the indigenous drum bellows. On the other hand, the large bellows which I have seen used in Fez, Morocco, resemble the concert-

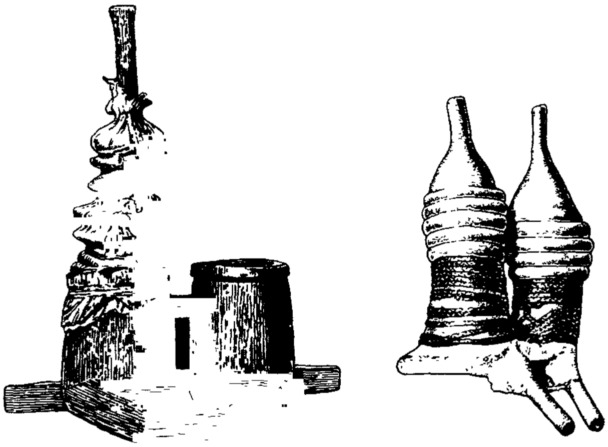
12. 62: Vol. 2, pp. 129-30; 134: Vol. 2, p. 802.
13. 62: Vol. 1, pp. 155-58.
14. 97: p. 167.
15. 139: pp. 323-24.
16. For all of the foregoing see 261: pp. 49-80.
17. 124: pp. 36-38.
18. 261: pp. 49-80.

ina type very closely, and the latter may thus be a direct introduction from Mediterranean lands.

The distribution of the three types may best be indicated in tables and maps.

TUYERES

Variations in tuyeres are slight and probably insignificant, though a student with sufficient patience might work out a typology which could be carried back to ancient forges and smelting sites.



a b

Fig. 14. Concertina bellows. a, Tome, Togo; b, Basari, Togo (after 164).

Some tribes of the Lake Leopold II - Lukenie region of the Congo (171), especially the Wadia, Tumba, BaSongo-meno, and Ba-Nkutu, often bake their tuyeres before using, even occasionally decorate them in the style common on their pottery vessels; but in most cases — as among the BaSakata, Ba-Lesa, and Mosengere of the same region — the tuyere is only sun-dried before being applied to the furnace or forge. It is usually made of a much coarser paste than is the household pottery, and the clay may be mixed with palm- or banana-fibres, as among the three tribes last mentioned, to render it less fragile.

As I have said, the tuyere is usually funnel-shaped, the broadest I have recorded being that of the Jur (61). Sometimes, as in Ungoni (97),[19] and among the Lobi (52), it is very long, while the Labwor of Uganda (296) make it of three or four funnel-shaped tubes fitted together and supported on sticks.

The following tables present the main features of the bellows in the most concise manner possible.

DISTRIBUTION TABLES

Drum Bellows with Clay Bodies

Tiong-ti town, near Tengrela (32)
Banjang (Ossidinge District) (164;175: pp. 113 ff.)
Banfora (92)
Lobi (Dagari) (52)
Ibo (15: pp. 171-76)
Chamba (Adamawa) (164)
Namtschi (Adamawa) (164)
Mandja (100: pp. 225-32)
Mangbetu (134: Vol. 2, p. 802; 199: pp. 265-71; 236)
Momfu (Nssoba village) (164; 260: p. 484)
Mpororo (164; 299)
Ababua (111: pp. 233-39; 134: Vol. 2, p.801)
Alur (260: p. 527)
Lugwari (181)
Jur (61)
Kuku (210: pp. 181-84)
Upper Nile (164)
BaNyankole (225: p.106)
BaGanda (224: pp. 381 ff.)
BaKitara (223: p.220)
Ruanda (62: Vol. 1, pp. 155-58; Vol. 3, pls. 12, 13, 14)
Karamojong tribes of Uganda (296)
Karagwe (164, 144)
Bakondjo (132: Vol. 2, pp. 628-29)
Bongo (164, 238)
Mosengere (Lake Leopold II-Lukenie region) (171)
BaSakata (Lake Leopold II-Lukenie region) (171)
Ipanga (Lake Leopold II-Lukenie region) (171)
BaTitu (Lake Leopold II-Lukenie region) (171)
BaLesa (Lake Leopold II-Lukenie region) (171)
Ondulu (traditional only) (217)

Drum Bellows with Both or All Chambers Cut from the Same Piece

Edo (275)
Liberia (133: Vol. 2, p. 1020)
West Africa (133: Vol. 2, p. 1020)
Yoruba (Ola-igbi village) (26)
Tschamba (Adamawa) (164)
Namtschi (Adamawa) (164)
Bakundu (164)
Pangwe (269: pp. 224-39)
Bakwiri (164)
BaLuba (58)
Jaunde (269: pp. 229-31)
BaNgala (297)
Mandja (100: pp. 225-32)
Lake Leopold II-Lukenie region (171)
BaSakata (4-chambered) (171)
BaFumungu (4-chambered) (old and rare)(171)
Tumba (4-chambered) (171)
BaLesa (4-chambered) (171) (4 or more chambered)

19. 97: p. 167.

Drum Bellows with Both or All Chambers Cut from the Same Piece (cont'd)

Bokala (4-chambered) (171)
BaNkutu (4-chambered) (171)
BaSongo-Meno (4-chambered) (171)
Ondulu (217)
Ovimbundu (114: pp. 158-61)
BaChokwe (130: p. 45)
Simariango village, near Longkwe River (161: p. 315)
Akela (4-chambered) (283: p. 195)
Northern Ruanda (62: Vol. 1, pp. 155-58)
WaRundi (43: pp. 51-52)
BaKondjo (62: Vol. 2, pp. 368-69)
Kavirondo (Uganda) (132: Vol. 2, p. 745)
Karamoja tribes of Uganda: Labwor,WaNdorobo, Dodotho, Jie, Karamojong (296)
Ungoni (97: pp. 170-71)
Ussangu (97: pp. 170-71)
Nyassa-Tanganyika Plateau (97: pp. 170-71)
Nyassa-Ruvuma district
WaKinga (37: pp.180-81; 261; 97: pp. 167-68)
WaLongo (260: p.117)
WaNyamwezi (104, 164)
WaPare (21: pp. 232-33)

Drum Bellows with Each Chamber a Separate Piece

Banfora (92)
Lobi (Dagari) (52)
Marghi ? (261)
Mayomba (196: pp. 195 ff.)
Djabir (7: p. 184)
BaPende (283: p. 350)
Abarambo (62: Vol. 5, pl. 93)
Ababua (111: pp. 233-39)
Ruanda (62: Vol. 1, pp. 155-58)
Kuku (210: pp. 181-84)
Bangongo (282: pp. 193-96)
BaGanda (224: pp. 381 ff.)
BaNyankole (225: p. 106)
Jur (61)
Masai (185: p. 112)
Ungoni (also double-chambered type) (37: pp. 180-81; 97: pp. 170-71)
BaYaka (283: p. 350)
BaIla (242: Vol.1, p. 211)
Momfu ? (261)
A-Lur (261; 260: p. 527)
Karagwe ? (261)
Urundi ? (261)
Mangbetu (62: Vol. 2, p. 129; 199:pp.265-71; 236: pp. 18-20)

Drum Bellows in West Africa

West Africa (133: Vol. 2, p. 1020)
Liberia (133: Vol. 2, p. 1020)
Banfora (92)
Tiong-ti town, near Tengrela (32)
Lobi (Dagari) (52)
Ibo (15: pp. 171-76)
Edo (275)
Banjang (Ossindinge District) (164; 175: pp. 113 ff.)
Yoruba (262: Vol. 3, pp. 923-28)
Angas (Northern Nigeria) (182)
Bagam (Cameroon) (173)
Bakwiri (164)
Namtschi (Adamawa) (164)
Tschamba (164)

Drum Bellows in South Africa

BaIla (242: Vol. 1, p. 211)
BaRotse (261)
WaMakua of Mozambique (261)
Makonde at Lindi (261)
Lomues at Kilimane (261)
Angoni (Ungoni) (261; 164; 37: pp. 180-81; 97: pp. 170-71)
Kafir (261)

Drum Bellows in the Central Sudan, the Congo, and Angola

Ababua (111: pp. 233-39; 134: Vol. 2, p.801)
Mandja (100: pp. 225-32)
Mangbetu (198; 62: Vol. 2, pp. 129-30; 199: pp. 265-71; 236: pp. 18-20)
Manyema (261; 46: p. 371)
Marghi (164)
Mayombe (196: pp. 195 ff.)
M'Baka (212)
Momfu (164; 260: p. 486)
Abarambo (Amadi town) (62: Vol. 5, pl.93)
Kuku (210: pp. 181-84)
Pangwe (269: pp. 224-39)
Upper Ogowe (73)
Fang (Osaka) (261)
Baya (222)
Nyangwe (261)
WaNekirumbo (260)
Lower Congo (261)
BaMbala (283: p. 350; 280)
BaNgala (261; 297)
BaPende (283: p. 350)
BaYaka (283: p. 350)
Akela (283: p. 350)
BaTetela (277)
BuShongo (282: pp. 193-96)
BaSonge (261; 283: p. 38; 198: pp. 223 ff.)
BaKondjo (62: Vol. 2, pp. 368-69)
Ganguella (261)
BaNgongo (282: pp. 193-96)
Angola (261)
Tshikunsa village, Angola (142)
BaChokwe (130: p. 45)
Djabir (7: p. 184)
BaKundu (164)
BaLuba
Ovambo (261; 154: Vol. 2, pp. 203-204)
Lokele (243: p. 15, plate)
Lake Leopold II-Lukenie region (171)
Ondulu (Bilie, Angola) (217)
Ovimbundu (114: pp. 158-61)
Kwasere village, near Pakhundi, eastern Congo (46: p. 236)

Drum Bellows in East Africa

Upper Nile (164)
A-Lur (at Wadelai: 261) (260: p. 523)
Bongo (164; 238)
Darfur (142; 229: Vol. 2, pp. 29 ff.)
Jur (61)
Lugwari (181)
Bari (261)
WaLongo (260: p. 117)
Unyoro (261)
WaRundi (261; 43: pp. 51-52)
Ruanda (62: Vol. 1, pp. 155-58)
Karamojong tribes of Uganda (296)
Kavirondo (Uganda) (132: Vol. 2, p. 745)
BaGanda (224: pp. 381 ff.)

Drum Bellows in East Africa (cont'd)

BaKitara (223: pp. 217-25)
BaNyankole (225: pp. 105-107)
Karagwe (164; 144: p.34)
Mpororo (164; 299: pl. 20, pp. 415 ff.)
Nandi (124: pp. 36-38)
Masai (185: pp. 110-14)
Ussangu (97: pp. 170-71)
Kindamba (261)
Ukinga (97: p. 168)
Iramba (218)
Irangi (164; 261)
WaItumba (151a)
Kibosho on Kilimandjaro (261)
WaChinga at Kilwa (261)
WaKonongo (261)
WaZegua (261)
WaHehe (261)
WaBena (261)
WaPogoro (261)
WaNgindo (261)
WaKimbu (218)
Nyassa-Ruvuma district
WaKinga (261; 37: pp. 180-81)
WaPare (21: pp. 232-33)
Kiziba (261)
Chuapa (261)
Simariango village, Longkwe River (161: p. 315)
Nyassa-Tanganyika Plateau (97: pp. 170-71)
WaNyassa (261)
Kissaka (Ruanda) (62: Vol. 3, pls. 12,13,14)

Bag Bellows in South Africa

Batwa (Northern Rhodesia) (169)
BaUshi (13)
Nyasaland (251)
Lamba (80: pp. 347-51)
BaLuba (Mumbwa District) (169)
BaLenje (Mumbwa District) (169)
Katanga (261; 150)
Manganja (161)
BaYeke (Katanga) (116)
Lake Nyassa (261; 161: pp. 506-509)
WaMakua (261)
Marawi (261)
Shangari (261)
WaNiassa (261)
BaTonga (261)
Karanga (177)
Mashona (268)
Angoni (261; 252)
AmaXosa (95: pp. 70-72)
BaGatlha (83: Vol. 2, section 2, pl. 23)
BaKaonde (184: p. 159)
BaKonde (261; 71: pp. 25-26)
BaSuto (261; 71: pp. 25-26)
BaHurutse (122: pp. 241-48)
BaVenda (255: p. 60)
BaThonga (137: Vol. 2, pp. 137-40)
Nama (230)
Kafir (Natal) (241: pp. 335-57; 142; 261: pp. 49-80; 122: pp. 241-48)
VaChopi (45: p.70)
Zulu (261: pp. 49-80; 33: p. 305)
BaYeke (Katanga) (116)

Bag Bellows in East Africa

Nile Valley (261)
Sennaar (261)

Bag Bellows in East Africa (cont'd)

Shilluk (256; 121: pp. 320-21; 303: p. 105)
Galla (261)
Akamba (261)
Kilimandjaro (261)
Akikuyu (227: pp. 79 ff.)
Chuka (195: pp. 129-31)
German East Coast (261)
WanIssansu (220)
Masai (261; 185: pp. 110-14)
WaSandawe (261; 75: pp. 108-109)
Tanga Coast (21: pp. 232-33)
WaMangandja (164)
WaNyamwezi (34: pp. 161-65)
WaNyaturu (218)
Safwa (145: Vol. 1, pp. 180-82)
WaChinga (at Kilwa) (261)
WaMatumbi (at Kilwa) (261)
WaGaia (at Shirati) (261)
WaSuba (at Shirati) (261)
WaSukuma (261)
WaSagara (261)
WaGogo (261)
Ufipa (307)
WanIrangi (261)
WaRufiyi (261)
WaZegua (261)
WaPogoro (261)
WaNgindo (261)
WaBena (261)
WaChagga (107)

Bag Bellows in West Africa

West Africa (74: Vol. 1, pp. 172 ff.)
Fouta (84: pp. 42-71)
Fouta Djallon (261)
Joloff (261)
Bambara (142; 293:Vol. 2, p. 97; 309)
Kamalia (261; 200: pp. 283-85)
Tiong-ti town near Tengrela (32: Vol. 1, pp. 79, 191)
Western Sudan (Beldeougou, Bammako,etc.) (261)
Senoufo (71: Vol. 1, pp. 263-66)
Moors (Senegambia) (31: pp. 118-19)
Mossi (174)
Nupe (182: Vol. 1, p. 156)
Habbe (78: pp. 368-69, pls.)
Hausa at Kano (267: pp. 207-15)
Hausa at Liruen (Riruwei)
Togo (261)
Bauchi (254)
Ivory Coast (261)
Ewe (Togo) (261)
Yoruba at Lagos (261)
Gurma (Western Sudan) (261)
Borgu (Northern Dahomey) (261)
Dendi (on Niger) (261)
Saberma (on Niger) (261)
Hausa (261)
Atakpame (Togo) (164, 261)
Togo and Cameroon (164)
Chandjo (Northern Togo) (261)
Kusuntu (Northern Togo) (261)
Balangua (Northern Togo) (261)
Kulumi (Northern Togo) (261)
Dagomba (Northern Togo) (261)
Aganyo (261)
Jaunde (164, 261)
Bornu (261)
Uyame (275)

XII. WIRE AND CHAIN

GENERAL DISTRIBUTION OF WIRE

Wire-drawing, as one of the refinements of metal-working, may be expected to show a limited distribution. So far as our data go, it occupies in the main two distinct areas: East Africa from the Horn south to Natal and west to the Katanga, and tropical West Africa between the Gongola and the Upper Niger. Within these areas not all groups practice it. Thus, the WaNyaturu (218)[1] and Wan-Issansu (218) do not draw wire, though surrounded by tribes who do; and while some of the BaRundi (43)[2] imitate the craft of the WaVira on their west, most of them have no knowledge of it, and beat their copper ornaments into shape rather than draw them (186).[3]

Wire drawing is rare or absent in the lands drained by the Shari River and between the many streams flowing into the Upper Nile from the west. Hambly's mention of it (114)[4] among the BaChokwe is the only instance I have recorded for Angola or the western or central parts of the Congo drainage. He expressly states that the Ovimbundu lack it.

Increasing information will probably credit many other people with this art, especially in West Africa, where the few and widely scattered marks on our map can hardly indicate the actual distribution.

For the interior of East Africa, several doubtful spots may be pointed out. The BaKitara make a few wire ornaments (223),[5] but I can find no statement that they draw their wire for themselves. The BaGanda smiths have learned to work copper and brass wire (224),[6] but here again we lack any definite assertion that they manufacture their own. At present it seems wise to interpret these hints negatively, since both the Kitara and Ganda cultures have much in common with that of the BaRundi, for whom we have a clear statement that wire-drawing is not indigenous (43).[7] But the WaVira, to the west of the BaRundi, draw fine iron and copper wire, the latter from the heavy stuff obtained through European trade (43).

Another doubtful area is the east coast. Here, in spite of our lack of information, I think we must assume that wire-drawing occurs, since it is commonly practiced in all large towns in Southern Arabia, whose traders and artisans have had contact with East Africa for hundreds of years.

One of the confusing factors is the widespread use of foreign trade wire. We find it brought into Africa centuries ago. Caton-Thompson (50)[8] suggests an Indian origin for the bronze wire at Zimbabwe, and Dapper (63)[9] in the seventeenth century wrote that the Dutch and Portuguese traded wire to the natives in Cambamba, Angola. At the present day enormous quantities are sold to natives by European traders or their middlemen, especially in East Africa and the Central Sudan. The Mangbetu import much of their copper in this form (199),[10] the WaTwa of Central Urundi make copper ornaments from wire imported from the coast (43);[11] and the WaPare of Usambara obtain large amounts of iron wire from Europe. All this undoubtedly prompted imitation, for the natives found it easy to draw finer gauges from coarse trade wire, and later learned to prepare their own metals for the drawplate.

The natives of Southern Rhodesia had wire of iron, copper, and bronze in the Middle Ages and probably much earlier. In the Zimbabwe Ruins (50) iron and copper wire were found in the midden deposit in Test Pit A3 at the Acropolis; a wire-drawer and copper or bronze wire in the Elliptical Building; bronze wire in Stratum 2 in the Maund Ruins. Iron wire was found in Stratum 3 of the midden deposit at the Hubvumi Ruins in the Bikita district, and in the Chiwona Kopje Ruins on the Sabi Reserve.

The technique of wire-drawing is so simple that a comparative study gives us few historical hints. The greatest variation occurs in the Southeast, where the natives employ the principle of the lever to draw the wire through the drawplate, which is firmly fixed. This may be due to the ancient drawing of bronze or to the present demand for heavier wires, which are harder to pull through by direct force of arm, since the natives practicing it use the direct hand method for the finer gauges.

WEST AFRICA

We have only two short descriptions of wire-drawing in West Africa. At Bauchi, Northern Nigeria, the Hausa smiths (182)[12] melt silver in a crucible under draught from the bellows, mix with it a little lead, and pour the mixture into a greased mould to form a bar three inches long and a third of an inch thick. They repeatedly heat this and

1. 218: pp. 58-59, 84.
2. 43: pp. 51-52.
3. 186: pp. 83-85.
4. 114: pp. 158-61.
5. 223: pp. 217-25.
6. 224: pp. 381 ff.
7. 43: pp. 51-52.
8. 50: pp. 64, 79.
9. 63: p. 368.
10. 199: pp. 265-71.
11. 43: pp. 51-52.
12. 182: Vol. 1, pp. 156-57.

beat it on the anvil till it takes the form of a flat strip twelve inches long and a quarter of an inch in breadth. Then, by hammer and chisel, they cut it lengthwise down the middle and beat each half round. Having been heated and greased, each of the pieces is then passed through successively smaller holes in a narrow iron drawplate, the artisan sitting on the ground and holding the drawplate against the soles of his feet. The Hausa make chain necklets from this wire, but we have no description of how they do it.

The Baya of the Cameroon (274)[13] draw wire from Hausa tin straws by passing them through holes in a piece of buffalo horn. The Bafia, however, make fine wire from the coarse brass wire of trade by hammering it down and shaving it carefully with a knife — a curious, makeshift method (271).[14]

For other West African groups the barest mention must suffice. Desplagne's report (78)[15] of copper filigree on the Central Nigerian Plateau may imply ancient wire-drawing in this area, though the filigree effect may have been produced by other means. Mungo Park found the Mandingo of Kamalia (Bambara?) drawing gold into wire (200).[16] Stuhlmann (261)[17] reports wire-drawing from Togo, by instruments similar to those about to be described from the East; and Talbot says that the Ibo make "fine twisted wire" (262).[18]

EAST AFRICA: DIRECT HAND DRAWING

Our best description of wire-drawing in the northern part of East Africa comes from the Akikuyu (227).[19] Having swept his stone anvil clean with a sword and with the wooden handle of his hammer, the Kikuyu smith heats his iron red hot and beats it into a long, four-sided bar with a pointed end. He drives this end into a piece of wood which will serve as a handle. Then he hammers the bar till it is a little less than a quarter of an inch thick, beats it down to a rounded cross section, and lengthens it by welding.

His drawplate is a flat, spindle-shaped piece of iron, pierced with seven holes of different sizes. He chooses the suitable hole, taps it with the butt of his cold chisel so as almost to close it, and then reopens it to the exact size he requires by inserting a large needle.

Having pointed the end of the bar by rubbing it between a maize cob and his stone anvil, he passes the point through the hole in the drawplate, and makes the point fast between the prongs of an iron vice. This instrument has somewhat the shape of a tuning fork. The wire is clamped into it by passing an iron ring over the prongs and driving a small iron wedge between them and the ring. Placing the drawplate in notches in stakes set in the ground, or holding it against the soles of his feet, the smith draws the vice toward him, thus pulling the wire through the plate. The Akikuyu draw all their wire cold. They declare that this technique and its equipment are indigenous and value native wire above trade wire for making a marriage collar.

The wire-drawers of Ruanda, who form a special class of artisans distinct from the smiths, also draw most of their wire cold, though they may heat the heavy grades slight-

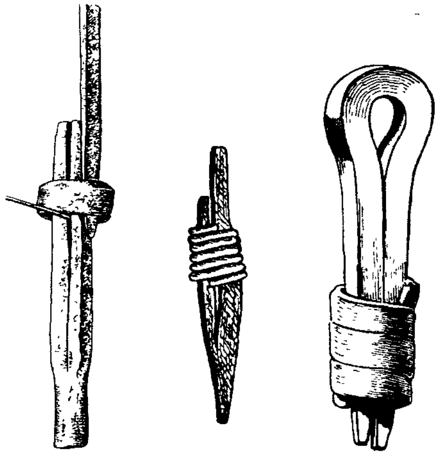


Fig. 15. Clamps for wire-drawing. a, Akikuyu; b, Masai; c, Bukoba (a, redrawn from 227, pl. 59; b, after 185, fig. 26b; c, after 260, fig. 229).

ly to facilitate the process. Their method agrees closely with that of the Akikuyu (62).[20]

EAST AFRICA: ROTATION METHOD

The BaNyamwezi, on the other hand, draw their copper wire hot (34),[21] just as they draw finer gauges from the heavy iron wire which they import from the coast (256).[22] The Southern BaNyamwezi and WaTusi employ the following method (256). They plant two perforated pieces of wood upright in the ground, passing a third, perforated at the middle, through the holes of the two uprights. After they have led the first stretch of wire, well greased with butter, through the drawplate, they pass it through the hole of the crosspiece and bind the drawplate to a tree. To the cross piece they then tie a small stick, by means of which they rotate it, coiling the wire around it.

The Masai (185)[23] follow about the same method for drawing fine wire from the heavy copper and brass wires of trade. They use a spindle-shaped or blunt-ended drawplate and

13. 274: p. 186.
14. 271: p. 149.
15. 78: pp. 368-69.
16. 200: p. 285.
17. 261: p. 60.
18. 262: pp. 923-28.
19. 227: pp. 98 ff.
20. 62: Vol. 1, pp. 157-58.
21. 34: pp. 161-65.
22. 256: pp. 152-63.
23. 185: pp. 110-14.

the same type of vice as the Kikuyu, closed by an iron coil forced over it. Though they draw the finer gauges directly by hand, for the heavier grades they hold the drawplate against a fork-shaped block of wood and coil the newly formed wire around a wooden roller which rotates in holes made in a forked post. Stuhlmann (260)[24] observed the same method at Bugurura village, Bugando district, Usindja, remarking that great quantities of iron wire are made in neighboring villages, as well as some of brass and copper.

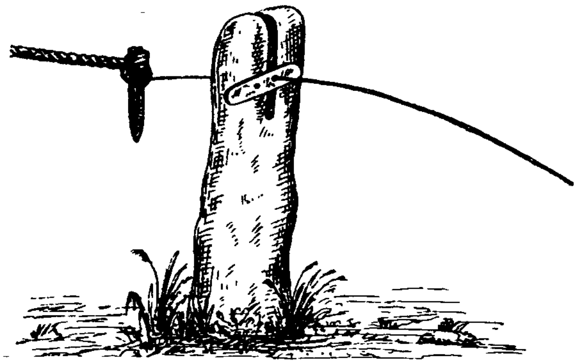


Fig. 16. Wire-drawing: Wakinga (after 97).

SOUTHEASTERN AFRICA AND THE KATANGA: LEVER METHOD

The BaYeke, migrating from the east, introduced the manufacture of wire into Katanga (150), and exported most of their copper in this form. They first pound the copper ingot into an irregular bar about three metres long and one centimetre thick, reheating it a number of times during the process. With an unhafted iron hammer, pointed at one end and flat at the other, they then carefully beat it till it is as regular as possible and has reached a length of about 460 cm. Having pounded one end very small, they pass it through a hole in a piece of iron which, in spite of its hemispherical form, we shall call the drawplate. They then insert this end through a hole in a long wooden lever, and clamp it in a vice made of two pieces of iron, with spiral iron rings driven over them to hold them tightly together. Placing this thin end of the wire in the fork of a post, four or five feet high, so that the vice is close on one side of the fork and the lever on the other, they brace the lower end of the lever against the post and the upper against the drawplate, and jerk the lever smartly, forcing the drawplate about thirty centimetres along the copper bar. It moves fairly easily, for the hole has been greased with peanut- or sesame-oil. Having gained this leeway, they prop the lever horizontally and rotate it on the post, forcing the drawplate with it and leaving a spiral of wire. The smiths thus turn out about fifteen metres of wire at the first drawing. To produce still finer gauges, they subject the wire to successive redrawing through smaller and smaller holes, greasing it, roasting it in a straw fire, and quenching it with water each time it is re-drawn, but not uncoiling it. Wires finer than two millimetres gauge are drawn by hand straight out of the drawplate, without use of post or lever, two men usually cooperating to give a strong, even tension. A single man can draw the finest grade, only half a millimetre in thickness, either holding the wire with his feet and pulling the drawplate toward him, or grasping the wire in one hand and pulling the drawplate with the other.

For the Nyasa-Ruvuma area, Fülleborn (97)[25] describes the production of fine wire from the heavy trade-wires of brass and copper. It is drawn through successively smaller holes in an iron plate (251), and held by a vice of the tuning-fork type which is clamped tight by an iron ring driven over it. So far, this looks like the simple Kikuyu method. But Fülleborn also mentions a perforated iron pin used for drawing wire on the Nyasa-Tanganyika Plateau and in Kondeland. Though he admits that he does not know how this was used, I suggest that it represents the process described by Stayt (255)[26] for the BaVenda, who stick their drawplate firmly into the trunk of a tree and lever the vice — similar to those above described — around the tree, leaving the wire behind it coiled around the trunk. In drawing finer wire the BaVenda hold the drawplate against the ground with their feet. The BaLemba — from whom, as we shall see, the BaVenda probably learned wire-drawing — stick their drawplate in a hole in an upright post, around which they wind the wire (232).

Holden (122),[27] quoting Moffat, says that the Baroutsie (BaHurutse?) drew bronze or brass bars into wire by passing them through holes in an iron plate; Griffith (285) reports tin wire from the Louis Trichardt district, Transvaal; and Chase mentions wire-drawing in Natal (55),[28] but we have no adequate descriptions of the technique this far south.

CHAIN MAKING

Chain making is mentioned without description for the following tribes and locations: West Africa in the eighteenth century (74),[29] Ibo (274), Mangbetu (iron as well as copper) (199, 236, 134),[30] Alur (260),[31] Latuka (260), Labwor (296), Ugogo (260), Baganda (132),[32] WaChagga (107), Akamba (107). Our only adequate account of the technique is from the Akikuyu (227).[33] The WaChagga,

24. 260: pp. 113-14.
25. 97: p. 173.
26. 255: pp. 65-66.
27. 122: pp. 247-48.
28. 55: Vol. 1, p. 6.
29. 74: p. 172 ff.
30. 199: pp. 265-71; 134: Vol. 2, p. 802.
31. 260: p. 816
32. 132: Vol. 2, p. 664.
33. 227: pp. 95-97.

near neighbors of the Akikuyu, say that they themselves have learned chain making from the Akamba (107). The Masai, on the other hand (185),[34] make no chain at all, but buy theirs from trading caravans or from adjoining tribes.

All Akikuyu use chain, but for ornament only. It is pratically uniform in pattern and manufacture, with no links longer than three-sixteenths of an inch, and no foreign chain is accepted in its place. "A hank of wire having been finally sized, by being passed through the draw-plate, is usually placed over one of the jaws of a forked stick stuck upright in the ground. The native sits down close to it. He then takes a metal rod some 24 in. in length, and of the thickness of a knitting needle, that has one of its ends firmly set into the long axis of a wooden handle about 9 in. long, like a round desk paper-ruler. He then laps one end of the suspended hank round the lower part of the metal rod, and then squeezes, between his right forefinger and thumb, the wire against the rod. At the same time he causes the rod to rotate by rolling the wooden cylinder, into which it is fixed, betwixt the inside of his flattened left hand and the outside of his left thigh. The flexible wire rapidly travels up the rod, which thus becomes covered by an evenly applied whipping of wire as a long spiral around it.

"The wooden handle is now removed, the rod with its whipping laid on a flat-topped stone, and a longitudinal cut made completely through the whipping, throughout its entire length, by means of a short wide chisel or punch struck with a wooden mallet. The wire whipping can now be slipped down the central core, when it falls apart as a series of links or circlets of fine wire." The artisan then flattens these links by tapping them with the butt of a chisel on a stone, and hooks them together.

"As the chain is formed, bit by bit ... it is carefully wound, under slight strain, round the middle two-fourths of a stick some 16 in. long and of the thickness of a child's wrist, in order to preserve it from falling apart, and the end is temporarily secured.... This stick or roller, with its coating of unriveted chain, is now laid on the ground close to a stone with a rounded top. Its ends are opposed by a couple of pegs driven into the earth. A short length of the yet unclosed chain is now drawn off the roller and stretched across the top of the anvil by the smith, who is seated on the ground facing both anvil and roller. With one hand he grasps the finished portion of the chain, if any such there be, or, in the case of a new length of chain, a terminal piece of string with the middle, third and fourth fingers, thereby maintaining a steady strain against the roller, whilst with the index finger and thumb of the same hand he so manipulates the link he is dealing with as to bring its opening uppermost. This done, he proceeds to bestow a sharp tap immediately over the opening with the side of the cutting end of his chisel held in the other hand." The finished chain is burnished by rubbing with sand. It is very smooth and does not develop defects on long use. The Akikuyu also make, but very rarely, fine copper chain out of trade wire, with fourteen links to the inch, instead of from seven to ten as has the iron chain made of their own wire.

This is probably the best chain made by African Negroes. That manufactured by the Labwor has broader links; and Stuhlmann notes a similar distinction between the chains made in Ugogo and Uguu (260),[35] the former having small, round links; the latter, longish ones.

METAL RIBBON

Though metal ribbon produced by hammering and cutting cannot properly be called wire, it is hard to separate the two products completely, especially when descriptions of the processes are so meagre. At least some of the coiled bracelets found by Caton-Thompson (50)[36] in Stratum 2 in the Maund Ruins, Zimbabwe, were made of bronze ribbon, rather than wire, coiled around a grass fibre core. The Mangbetu make "flat wire" of copper (199),[37] but I can find no account of its manufacture. On the other hand, the BaNgala definitely make brass ribbon by beating out brass currency rods to the required width (297). It is therefore suggested that metal ribbon, rather than wire, is typical for the northern Congo, and that it may have preceded wire in Negro Africa as a whole.

DIFFUSION

Reviewing the distribution of wire-drawing in Negro Africa, we can hardly escape the conclusion that it was originally introduced from outside. Stuhlmann (261)[38] points out that the iron drawplate, and the vice with its spiral ring for clamping the prongs tightly together are similar in Usindja, Bukoba, Ruanda, Kondeland, Togo, and among the Hausa and Masai, and suggest an origin of wire-drawing in Northeast Africa or Asia. The art occurs in precisely those two areas which have been exposed to influences from the Arab and Mediterranean worlds for the longest time. We must, of course, allow for a considerable amount of diffusion from the original points of contact, such as the introduction of wire-drawing into the Katanga with the westward migration of the BaYeke, and for several native variations.

With regard to these variations, I may add that I have seen Arabs in Makalla, on

34. 185: p. 114.
35. 260: p. 816.
36. 50: p. 48.
37. 199: pp. 265-71.
38. 261: p. 60.

the South Arabian coast, drawing iron wire by the rotating beam method, such as is used by the Masai and the BaNyamwezi. Since the latter tribe have played a prominent part as porters and middlemen between the east coast and the regions south and west of Lake Tanganyika, we may suggest that they carried this method to the BaYeke and their relatives; rather than that wire-drawing was introduced to the BaNyamwezi from the Katinga, as Blohm believes (34).[39] The BaYeke seem to have modified the technique so that the roller became a stationary, vertical post, around which the wire was coiled by leverage. The Masai, who probably received wire-drawing through the same channels, preserved the technique in its original form. The facts that the Akikuyu are the one tribe in our records who draw iron wire only, and that they do this by the simplest method — direct tension by hand — tend to substantiate their claim that the art is indigenous among them, or to suggest that the Akikuyu did not derive it at the same time, and from the same source, as did the other groups.

Zimbabwe undoubtedly played a prominent part in the story, and may have been the center of diffusion for the southern form of the technique. From Zimbabwe the art seems to have descended to the BaLemba, who, according to Junod (136), introduced it to the BaSuto, BaVenda and BaThonga in relatively recent times, by means of "two special tools which greatly astonished the natives: one, the magogo, was a piece of iron with holes in it, of different sizes; the other, a kind of pincers called ngwenya, viz., the crocodile."

One use of wire shows a continuity with the Zimbabwe culture and has had an interesting distribution within recent years. In Stratum 2 of the Maund Ruins, Caton-Thompson (50)[40] found bracelets of bronze wire coiled over a grass core. She states that they "remained unaltered throughout the whole archaeological history of Zimbabwe." Now the BaYeke sell most of their fine wire in the form of bracelets, in which it is spiralled around a core of bukenge fibres, goat hair, or antelope hair. They measure these bracelets by the diameter of the human foot between the heel and the ankle, and may leave them open for purposes of trade. The BaLemba (136) of the Spelonken and Selati districts, Transvaal, made bracelets of precisely the same type, which served as the chief currency in their dealings with the BaThonga, BaSuto, and other tribes around them. As we have seen in the section on casting, they obtain in return the "marali" or "ritsondjolo" bars, the slimness of which makes them particularly amenable to wire drawing. Lemba and Venda men make the coiled bracelets especially for their women, the BaVenda coiling the wire around a core of cattle hairs (255), the BaLemba around the hairs of zebra, horse, or cattle (136, 232).[41] The BaNyamwezi have copper wire bracelets of the same type (34),[42] and Colle's description (58)[43] of the BaLuba bracelets of copper wire seems to indicate the same. Here, then, we have a single technique which has continued from the old Zimbabwe culture to the BaLemba and BaVenda, who show several other Zimbabwe affinities, and has apparently spread north to the BaNyamwezi and west to the Katanga with the BaYeke invasion.

39. 34: pp. 161-65.
40. 50: p. 48.
41. 232: p. 69.
42. 34: pp. 161-65.
43. 58: pp. 223-25.

XIII. THE SOCIAL AND RELIGIOUS ASPECTS OF METAL-WORKING

EXAMPLES

Everyone who has heard of Negro metal-working knows that it has magico-religious associations, and that Negro smiths sometimes rate as shamans or religious leaders, sometimes as the lowest pariahs. It is commonly rumored that these peculiar values have something to do with the novel and mysterious nature of the metal itself. This assumption would suggest that we might learn something of the history of Negro metallurgy by a comparative study of such attitudes; perhaps might even go so far as to infer that the craft is youngest among tribes who ritualize it most, that metal-working guilds represent enlightened immigrants who have travelled on the secrets of their trade, and that depressed castes of iron-workers are the remains of indigenous peoples who have been enslaved and kept at their work by more powerful but less ingenious conquerors.

To any modern ethnologist such ways of thought seem quite silly, but we have not left them so far behind us that we can afford completely to overlook them. I shall therefore present what material I have gathered on this subject, partly to knock down this man of straw, partly to suggest a few minor ideas of my own and to give a faint touch of life to a paper so full of deadly technology. The suggestions must remain extremely tentative, since a treatment of the complete social and religious context of the customs in question would carry us far beyond the main problems before us.

Only a few cases have been sufficiently described to merit discussion; but even these show us what varied forms the ritualization of metal-working may assume, and many details suggest that these forms depend rather on other conditions within the culture than on a peculiar set of social and religious attitudes which the craft carries with it.

Masai

The Masai (123,185)[1] provide the classic example of a despised smith caste. God offered three implements to man: a herdsman's staff, a bow, and a smith's hammer; and when the ancestors of the pastoral and hunting groups had chosen respectively the first two, nothing but the hammer was left for the unfortunate ancestral smith. The first smith in the Masai country came as an immigrant long ago and married a Masai girl; their son, Taraeti, becoming the first Masai to practice the profession.

Though Masai smiths do not form a separate tribe or gens, being distributed among all three of the main territorial groups and among all gentes except God's favored El Kiboron, they have separate dwelling kraals, separate warriors' kraals and war parties, and are endogamous, the normal tribesmen avoiding even informal sexual intercourse with their women. The craft is inherited from father to son, the son first practising it after his marriage. The hunting WaNdorobbo, though themselves counted as low savages by the Masai, likewise despise smiths, who have no legal rights in Masai or Ndorobbo communities and may even be murdered by their social superiors without redress. A smith cannot leave his caste by failing to practice the profession; nor, on the other hand, can a non-member make his way into the caste by doing smith's work, though everyone will look askance at him. Even a smith's exceptional skill, though it may inflame the jealousy of neighboring Masai groups who cannot command his services, fails to elevate him socially among the warriors for whom he works. A normal Masai never expects hospitality from a smith, nor extends him any.

The Masai give several explanations for the smith's peculiar status. In the first place, he and his kind are accursed of God because he makes weapons, and God dislikes bloodshed. This curse has made them eternally impure and supernaturally dangerous to their neighbors. The proximity of a smiths' kraal may bring to a normal kraal death, sickness, and various misfortunes. Sexual intercourse with a woman of the smith caste will cause a man to lose his reason, to beget defective children, or to be killed in the next raid. Ol Kononi — "a smith" — is a term of insult when applied to a non-smith; and to pronounce this word after dark is to invite the nocturnal attacks of lions or human enemies. Even the smith's handiwork is unclean. The Tatoga and Iraku, tribes culturally allied with the Masai, take a new iron object to a brook at some distance from the smithy and wash from it and from their hands the impurity which was imparted by contact with the smith; and the Masai do so with fat instead of water.

Except within the narrow limits of their calling, failure dogs the smiths everywhere, for their Masai patrons may take from them the small booty which they bring back

1. 123: pp. 330-31; 185: pp. 47, 110-14, 207, 246, 265, 306-11.

from their raids, and if they manage to achieve some measure of worldly success, for reasons best known to the Almighty they soon die.

Looking beneath this set of beliefs and practices for a more common-sense reason for the smith's lowly status, we are struck at once with the fact that his profession tends to remove him from normal Masai life. Smiths are more sedentary than other Masai because they must keep their kraals near good sources of ore and wood. This restricts their wandering in search of pasture for their herds, and consequently the number of animals which they can raise. Moreover, they are "the men behind the men behind the guns." They make the spears and swords by which other men gain glory. When the Masai brotherhoods are on the rampage in quest of blood and cattle, the smiths will be bending over their forges; and any warlike sallies of their own, which would distract them from their work, are bound to be discouraged. This exclusion from the two activities most vital to the Masai — cattle-raising and fighting — undoubtedly accounts for most of the stigma attached to the smiths.

Strange to say, they seem not to ritualize their work in any way; in fact, they are one of the few African groups in which women normally take part in smelting and forging, women frequently working the bellows.

We find attitudes similar to the Masai among the neighboring Suk, where only poor agricultural people engage in metallurgy, "God having given them no sheep, but brains instead;" the Elgeyo, whose iron-workers are a lowly, endogamous group, not allowed to keep livestock "because if they became rich they would stop working;" the Bari, whose smiths, though they may acquire cattle, are distinct from the true cattle-keeping Bari, usually live in separate villages, and are looked down upon; and the Somali, whose smiths are a despised caste.

WaChagga

When we turn to the WaChagga (107), whose smiths are said to have come from the Masai, we get an entirely different picture. Here the smiths are confined to certain sibs who traditionally introduced the craft. They do not form a despised caste, but are both feared and honored. Gutmann gives three reasons for this: because they make deadly weapons, because they possess the secret of "binding iron together," and because their hammers and bellows do superhuman work. Another factor in the complex, but a hard one to evaluate, is the sociability engendered in the smithy. Men love to gather there to gossip, and are moved to say things in the presence of the smith which they would otherwise confide only to a shaman or diviner. The supernatural atmosphere is enhanced by the fact that the client watches the smith bring the new tool or weapon into being, watches the sparks fly in showers without harming him; and while these mysterious transformations proceed, the smith is ever ready to talk about the client's personal affairs.

The only obvious handicaps suffered by Chagga smiths are in matters of marriage. An outsider does not like to give his daughter to a smith, since to divorce him would expose her to great danger. Should the divorce become necessary, the smith may free her by rubbing her all over with butter in the presence of his mother or another female witness — a method reminiscent of the Masai way of removing the smith's contamination from a new iron object — and by handing her a staff before he pronounces the divorce. The converse taboo, on the marriage of a smith's daughter to an outsider, refers to the dangerous potency of smith's blood. The fear of this blood is so strong that no layman will bleed a smith voluntarily; and smiths are consequently obliged to practice blood-letting for each other. Since defloration and menstruation would involve the spilling of such blood, marriage with a smith's daughter will bring the non-smith early to the grave. The WaChagga say this also about girls of some other sibs, but then give other reasons. The smiths' sibs are not alone, moreover, in possessing dangerous blood; chiefs share the same disadvantage, and the blood of maternal uncles is perilous for their sisters' children. The reference to chiefs in this connection is especially interesting, since the WaChagga of the Moshi district forbid intermarriage between the chief's sib and the smiths'; explaining that a smith once laid a curse on his daughter when he became involved in a quarrel with a chief — presumably her husband or suitor. The Moshi people, however, do not keep this taboo very strictly, since their smiths, for reasons stated above, often have considerable difficulty in finding wives for themselves.

The WaChagga in the northern part of Kilimandjaro district, who say that God hates the makers of deadly weapons, forbid smiths to go on the war-path with them, for their presence is likely to bring death; but since Masai are more thickly settled here than elsewhere in Chagga territory, we may assume that this is an instance of simple diffusion. At any rate, the very opposite attitude prevails in Moshi and eastern Kilimandjaro, where smiths who miss a war-party receive a gift of cattle as compensation. Smiths should not dwell, however, on the steppe borders of the Chagga territory. It is said that they would grow ill there; but the real reason is probably that their hamlets are safer from enemies if located in more central districts.

Special power dwells in the smith's hammer, as the chief bearer of all the spiritual force of his profession. When he has broken it or worn it out, he may rework its iron only into tools for himself. Though he only receives a young cow from his son or other relative to whom he presents his other

products, he must present the hammer with much ceremony, since it bears a high magical charge and is dangerous for all who have not ritually been allied with it. Before beginning to make a hammer for anyone, he receives from the client a goat and a quantity of beer. As he proceeds with the work, surrounded by the participants in the rite, the goat is slaughtered and its flesh boiled for the ensuing feast. The hot hammer is "cooled" in a special concoction mixed with the stomach contents of the goat, the husks of grain left from brewing the beer, and the leaves of the jaunde bush — all things of great spiritual potency — ostensibly not to temper it but to tone down its supernatural strength. From a brush of sacred herbs an elder then sprinkles the concoction over the company, especially over the owner of the hammer, with a general blessing and a wish that the hammer may do its owner no harm. When he has brought it home, the owner must hold a feast for the members of his sib, to place them in the hammer's good graces. When he marries, the smith hands the hammer to his bride, telling her to lift it up and not to claim damages from him if it ever injures her, and expressing the wish that she may bear a son who will also forge with a hammer. Should it injure anyone else, directly or indirectly, the injured one can claim damages from the smith, and must expiate his own offense by giving a feast to prevent his own death. A goat is slaughtered, and the smith and the injured party place rings of its skin on their forefingers, pronouncing a formula of atonement. The same rite is necessary when the smith accidentally hits anyone with his slag, or when he points at anyone. If the hammer slips from its handle during work, the smith says to his client, who is standing by, "The chief desires what is yours. I must keep this iron and not forge it till you have satisfied him." The client then brings a goat, which they slaughter and eat together, placing rings of its skin on their forefingers with a blessing; and having placed another ring of the goatskin on the hammer's handle, the smith goes on with the work. If a piece of the hammer breaks off during the forging, the client must pay a goat for the breakage, and the smith says to him, "Your ancestors grasp for you. Go and consult a diviner" — that proper atonement be made.

Though a smith may unloose the spiritual power of his other tools to enact a curse on a thief or personal enemy, he uses his hammers especially for this purpose, just as the chief uses his cursing-pot and cursing-bells, by knocking them together as he loudly pronounces the malediction.

But not all of his powers and susceptibilities are directly associated with his hammer. If one jokingly or by mistake points the tongs at the smith, he must give a goat as an expiatory sacrifice, for his imprudent act has made the smith liable to be bitten by a snake.

Smiths are death to thieves. They wield such strong powers against them that the precincts of the smith protect any property which is left there. If the thief has left tracks behind him, the smith scoops some earth from the footprints in a piece of banana bark and puts it in his forge; and as the bellows-boy is blowing up the fire, the smith tells the offender to swell up and die. People beg fragments of his old tuyeres to place in their huts as charms against theft. In the process of charcoal-making, when the smith is breaking down the burning pile and strewing the coals over the ground to cool, he pronounces blessings and curses, sympathetic magical formulae referring to this process; praying for the perfect smelting of the iron, and for criminals and personal enemies — always explicitly excepting the chief — to be destroyed and scattered as are the pieces of wood burning to charcoal.

Many omens may be taken from the smith's work. If charcoal supposedly cool breaks into fire while it is being transported or when it has been deposited in the hut, this deadly omen must be averted by the sacrifice of a goat. The irregularities of the slag allow a wide range of prognostications. Thus a hole breaking open in the slag mass portends "a grave for somebody" — usually the client for whom the work is being done, who must then consult a diviner and make a propitiatory sacrifice. Smiths may be called upon to interpret, in a semi-professional way, the forms taken by the slag. They often conceal their own lack of skill by attributing technical failures to supernatural intervention of this kind.

Though they usually do not exploit their powers for purposes of evil magic or deception, many are famed as beneficent shamans who have saved people from witchcraft by giving them medicines from their smithies. Iron makes efficacious amulets and curatives. Women of the western WaChagga wear spiral iron rings around their necks or arms, believing that they give fertility and cure their sick children. When the shaman has prescribed one, the smith brings it to the client's hut, and in the presence of her husband places it upon her, spits on it four times — four being the ritualistic number of the WaChagga — and pronounces the blessing. He also gives her two small iron arrowheads, of the kind used to pierce the blocked arteries of goats or cattle in order to draw blood for parturient women to drink or to relieve the animal of sickness. As he does so he tells her to give them to a blood-letter; which, next morning, she does. He hands a piece of iron to her sister, telling her to lift it up — vide the formula used by the smith in introducing his bride to the hammer — and directing her to summon her sister to her aid if she herself is ever ill. The presentation of these iron objects is followed by beer-drinking, dancing, and the singing of old songs of blessing. Men also, when their cattle are not giving sufficient milk or when bees fail to nest in the empty hives placed out for them, obtain these iron rings from the smith with a simi-

lar ceremony; and the smith later brings the client a new sickle to cut banana stalks for his cattle, pronouncing at the same time a blessing on the cattle and their produce. Bleeding-arrows for cattle are forged in a batch, all in four days.

As if in contradiction of the above attitudes, the magical force inherent in iron is inimical to life and peace. In the rite of blood brotherhood, the contracting parties must not have any iron on their persons; it would nullify the bond. This injunction is sometimes secretly violated by people taking the oath insincerely — especially by the Kibosho and Kahe people, who are notoriously treacherous.

Attitudes similar to those of the WaChagga are held by the Nandi, among whom a smith's curse is fatal and his anvil never parted with; the AKikuyu, who believe that a smith's curse is especially "biting and adhesive" and who use old tuyeres to protect property and crops; the Lango, where the smithy is inviolable from theft and trespass; the WaChuka, who use an old tuyere as a potent charm and credit their smiths with special magical powers; the Latuka, whose men make use of the smithy as a kind of clubhouse.

In comparing the WaChagga and Masai, we observed for the first time the negative correlation between the despised smith caste and the ritualization of metal working. The higher social position of the Chagga smiths may be due to the more tolerant attitude of the WaChagga toward non-pastoral occupations.

BaKitara

Though lacking blacksmiths' guilds or a clearly marked, hereditary caste of smiths, the BaKitara of Unyoro (223)[2] ritualize iron-working and its accessories in ways which reflect many other aspects of their social and economic organization. They divide the work among three classes of artisans: miners and smelters, pig-iron workers, and smiths. These classes never share in each other's work, but each sells its produce to the other. That they all may be drawn from any clan of the serf group (BaHera), may partially account for the lack of a special caste of iron-workers, since, by the most fundamental postulate of the Kitara social system, all manual labor other than the care of cattle is relegated to the subservient BaHera.

When we examine mining, we at once meet the Kitara tendency to ritualize all the materials and apparatus of industry. Ore is either "male" or "female:" the first hard, black, and from the surface of the ground; the second soft, red, and mined in tunnels; and a mixture of both of these "sexes" is necessary for successful smelting. This, however, may be a purely practical consideration, or one with only a slight tinge of ritual; since the hard magnetite requires roasting, which might be accomplished in the smelting furnace if a more tractible ore is mixed with it.

Miners have to propitiate the hill-spirit presiding over the mines, not only to obtain good iron but to prevent the mines from collapsing. A hole on the hill,"probably of volcanic origin," has to be carefully covered over and given an offering, lest it send out a rain-bearing wind which would impair the work. The BaHera seem to have modified these aboriginal rites in deference to the immigrant ruling class, since in later times they have made their offerings through the Huma chief of the mining district.

Mining taboos are many and various. During their work, miners not only have to observe "all the taboos usual at the beginning of any work," but special ones for the occasion, such as those against approaching their wives or washing. Meeting a dog portends evil, and each miner has been warned by the shaman against unfavorable omens which apply especially to him, such as meeting a man, or a woman.

Even the charcoal has its restrictions. While preparing it, the smelter observes many taboos and watches for bad omens, both general and particular. Having gone to cut the wood, he returns with two pieces; one of these he gives to his wife for kitchen use, the other he puts on his own fire. This removes the taboo against contact with his wife, but not against sexual intercourse, which binds him until the charcoal is ready for use. It also averts the harm which would be caused him if anyone used his smelting charcoal for ordinary purposes, and insures the success of the charcoal in the furnace.

The bellows are likewise sensitive creatures. If the manufacturers had sexual intercourse while making them, they would constantly fill with water and refuse to create a draught. The smith, however,who makes his own bellows, has sexual intercourse with his wife as soon as the bellows are ready for use, to make them sound and ensure their working well.

The iron might fail to smelt if the smelters ate potatoes, if women — especially menstruant women — came near the furnace, or if a man whose wife had just borne a child took part in the work. During the process the smelters often eat nothing but plantain and maize on the cob, cooked over the furnace.

Subsequent activities by the pig-iron workers and smiths introduce two more ticklish personalities, the anvil and hammer. While seeking stones to be used as such, the

2. 223: pp. 217-25.

artisan observed all the working taboos, including continence on the preceding night. When he has found suitable stones, he pays three hundred cowries to the chief of the land for permission to take them away; scatters millet, sesame, and beans over the anvil stone, and sacrifices a sheep and a fowl, allowing the blood to run over it. His assistants eat the meat beside the stone, while he asks it to accept the sacrifice and be a good anvil. From this point to their installation in the shop, the anvil, carefully covered with bark-cloth, receives the treatment accorded a bride, while the hammer — a small stone found near it — is treated as its child.

While the men carry the stones homeward, they sing as in a nuptial procession. The artisan's wife, dressed in her best bark-cloths with a creeper wreath on her head, comes out bringing millet, sesame, and beans, and greets the anvil like a bride. The owner scatters the grain and beans over it, and if it is the kind used for the finishing of tools and weapons, he sprinkles it with water by means of a bunch of purificatory herbs "so that it might bear many children." After it has been paraded into the house with nuptial singing and dancing, he tells his wife that he has brought a second wife home to help her. Pig-iron workers seclude the stones in the house for four days, smiths for two days, before bringing them out and preparing them for use.

The BaKitara share the general idea of hammer ritualization with the WaChagga and several other groups we shall mention, but their identification of anvil with bride is a very curious one, and I can suggest only a partial explanation. The BaBali of the Ituri forest, just west of here, are the most accomplished blacksmiths of their region, and frequently use anvils as a medium of bride-price. Some of their neighbors pay bride price in anvils alone. One often suspects — though to prove the point would necessitate a careful analysis — that the BaHera must have had fundamentally an eastern Congo culture before they were subjugated by the pastoral BaHuma. Since all artisans in Kitara-land are BaHera, it is barely possible that the anvil-bride identification expresses the antagonism of artisans for herdsmen, by asserting the old native form of bride-price as opposed to the bride-price in cattle which the BaHuma, with their intensively pastoral culture, employ.

The smith inaugurates the new anvil by making a knife which he must not sell in the market, but must exchange for millet which his wife boils as porridge and shares with him in a sacramental meal.

He may not touch his iron hammer until it is finished, and attends its manufacture under stringent taboos against approaching his wife or washing. The assistants who make it for him do most of the work before dawn, and his father plunges it in water to temper it. After a feast for all the assistants and a payment of four hundred cowries to the maker of the hammer, the smith has intercourse with his wife and secludes the hammer in his house for two days. He inaugurates it, just as he did the anvil, by making a knife which he exchanges for butter, tobacco, and coffee-berries as gifts for his parents.

BaNyankole

The BaNyankole (225)[3] have a very weak version of all the formalities of smelting and forging found among the Bakitara. Their metal workers comprise a single profession, doing all the work from mining to the finishing of implements. As among the BaKitara, they belong to the serf class, and the king can command their services, though he always compensates them.

During smelting, no Ankole smith may have intercourse with any woman except his wife, nor come near any menstruating woman; he may not step over the wood from which he is making his charcoal, and should he be seated on the doorstep of his hut, no one may enter or come out till he has arisen. These restrictions are in force till he has made a hoe from the new batch of iron.

The rites for a new anvil and hammer are mere remnants of the Kitara forms. The night before seeking the new anvil, the smith avoids all women but his wife. In the morning, fasting, he sets out on the quest with a party of male friends, who carry the stone home for him and are rewarded with a feast, in which the smith and his relatives partake. Millet and certain purificatory herbs are placed in the hole in which the anvil is to stand.

New hammer ceremonies are likewise simple. The smith kills several goats for a feast for the fellow-craftsmen who come to help him make the hammer. They work on the hammer all night. In the morning, when it is finished, the smith summons his wife, his parents, and his grandparents to a pit which has been dug in the ground and filled with three or four gallons of water. The father and grandfather quench the hot hammer in this water to harden it, and as it lies in the water they pass over it certain sacred herbs to purify and bless it. The hammer is then carried into the smith's hut, where the feast is prepared and consumed. Any fibre in which the iron had been wrapped and which had clung to it before forging is put at the head of the smith's bed, while the hammer is laid at the foot; and the smith copulates with his wife on the bed to complete the ceremonies. After two or three days he makes a knife or a hoe

3. 225: pp. 105-107.

from some of the iron which was smelted in the same batch as the iron for the hammer, and gives this to some member of his family to show that the hammer works well.

The tribes of the Nyasaland-Katanga belt, to be represented here by the BaUshi, Achewa, BaYeke, BaIla, and the people of Ufipa, seem to be characterized by a smelters' guild rather than by a smiths' caste, by a greater ritualization of smelting than of forging — especially in the use of smelting "medicines" — and possibly the importance of dead ancestral smiths, though this element is not reported from Ufipa or from the Achewa and BaIla.

BaUshi

Ushi smiths are usually distinct from smelting experts, who formerly worked under the direct orders of the chief (13). The BaUshi associate iron-smelting with the dead, always building their furnaces on an ancient smelting site. Near the furnace they erect a shrine about three feet high, without walls, the point of the concical roof decorated like that of a dwelling. Between the shrine and the furnace stands a short post with "medicinal" leaves tied around its top; and from the mud cushion in which this post is set radiate a series of "medicinal" sticks. After breaking the ore into small pieces, the smelters heap it up before the shrine; kill a fowl there, stick its head on the peak of the shrine, and sprinkle the ore with its blood. Its flesh is eaten with porridge by the expert smelters. The smelters then pray to the men of old time who smelted iron here, for success in the forthcoming operation. When they have charged the furnace, they place upon the final charcoal layer a special charm, wrapped in a nest of grass and leaves. No ceremonial seems to accompany the refining of the crude iron, except that each time the smelter has emptied a basket of iron into the furnace he waves the basket over his head and sets it on the ground.

Achewa

Among the Achewa (120) of Dowa district, Nyasaland Protectorate, when a man wishes to make a smelting furnace he consults a doctor (sing'anga), who puts medicine in a stripped maize cob and instructs a small boy to throw this at a pregnant woman, causing her to miscarry. The doctor then digs the foetus from the refuse heap, mixes it with a special medicine, and burns it in a hole in the ground. The clay wall of the furnace is then constructed over this hole. Then more medicine and a sacrificed fowl are thrown over the furnace. If the fowl falls with its head pointing north, the furnace is no good and another must be made elsewhere a month later. If the fowl falls favorably, it is plucked, roasted whole, and eaten with maize porridge by the people who have made the furnace. All Achewa smelters observe strict sexual continence during the work. When they have made hoes from the newly smelted iron, they give some to the woman who had the miscarriage, but she should not know the reason for the gift! This use of the human foetus remind us of the Atonga custom of throwing a piece of an afterbirth into the furnace to further smelting.

Katanga: the BaYeke and Others

Katanga (116) metal-workers form a "bwanga," a religious society with initiation and a cult of its own, in which rites for the souls of deceased members play a big part. The BaSanga, for example, revere an ancestral copper-smith who exploited certain mines. Tradition relates that the first BaYeke miners in the Katanga were initiated by the local BaSanga, lest the spirits of the mines take offense at the intrusion of foreigners. Soon, however, the BaYeke had developed their own guild of copper workers, with its tutelary spirits, and were actually initiating the BaSanga. The number of these BaYeke "copper-eaters" — that is, those who consume or draw profits from the copper — has always been very limited. Many BaYeke chiefs do not belong. All members are ipso facto qualified hunters, and can pursue any animal except the elephant, which requires a special initiation. Among the BaYeke of the Dikuluwe, and probably among other groups, sons of chiefs need pay no fee for initiation into the guild. Arnot (10)[4] says that in Garenganze, between the Lufira and the Dikuluwe, copper-smelting is inherited patrilineally in certain families, while iron-working is inherited in other families in the same way. On the other hand, P. K. Horner (219), an English mining engineer describing native copper working at Dikuluwe, says that the secrets of metallurgy are retained by the old women of the village, who are highly respected.

The BaYeke (116) strongly ritualize the mining and smelting processes. Before going to the mines to begin the season's work, the chief, surrounded by a shaman and the copper workers, recites a suitable prayer to his ancestral copper-working spirits who preside over the mine. Since mining has religious as well as technical difficulties, being apt to disturb the spirits of the mountain, he determines where the digging shall be done, and plants three magical stakes around the circumference of the mine to prevent the walls from collapsing. He also sprays a special bark concoction from his mouth over the ground to be dug.

Smelting has a still more ceremonial character, and is usually done at night. Charcoal burners place a piece of luck-bringing musongwa-songwe wood on the pile of mobanga or other wood before burning the latter to charcoal, and set up at each end

4. 10: pp. 238–39.

of the pile a small termite hill — these hills being ritually associated with metal-working through the use of termite earth for furnaces.

Smelting involves several ceremonial precautions. A master smelter directs the work, while a shaman takes charge of the magico-religious details. Two barks are used ritually in the smelting process: one from a spiny bush growing on anthills, the other from a large tree in the forest. From these the shaman prepares an infusion with which the master smelter washes his hands and face before beginning the operations. A piece of bark is placed on the charcoal after the furnace has been filled and lighted. When the smelting is nearly finished, the master smelter brings six pieces of the sacred barks and a bark receptacle full of the infusion. He throws a piece into each of the tuyeres, sprinkles the infusion over the furnace by means of a brush of herbs, and throws more bark into the tuyeres. After this the joyful on-lookers break into rhythmic hand-clapping, raising their songs to the night sky, which glows with the furnace fires: "A smelting furnace is erected on the summit of Kalabi, a smelting furnace with a large belly, the heritage of our father Loupedila, a smelting furnace in which the copper drips and flows!" " O my mother, O my mother!" At this the spirits of the mountain touch the ore and make the copper flow out.

Supernatural forces seem to stop at the completion of smelting. Nothing in the accounts suggests that the refining, casting, or shaping of the metal are more than purely secular affairs, though members of the guild perform them under the direction of the master smelter. I find, however, no explicit statement on this important division between the sacred and the profane; and even within the activities of mining and smelting our Belgian authorities leave many ambiguities and doubts. This is especially true with regard to the identity and respective functions of shaman, master smelter, and chief. De Hemptinne writes of the shaman as distinct from the chief; but who is the "master smelter" to whom this author repeatedly refers? Is he usually, always, or never the chief; or may he be the shaman who prepares the magical infusions of bark and prescribes the sacred woods? Ladame (150), describing copper-working for the Katanga region in general without specifying his tribe, tells us that each tribe has its master-smelter, highly respected, who possesses the necessary secrets for the work and after whom the mine is often named. But he identifies him with the shaman, and says nothing about his relation to the chief. Ladame adds that the smelters allow no women at the smelting place, that men are forbidden sexual intercourse during the mining season, under pain of a good bath and two days' absence from the furnaces: particulars which de Hemptinne does not mention for the BaYeke. Since Ladame proceeds to describe a smelting technique quite different from that of the BaYeke, I think we may assume that he is dealing with another tribe. We may safely guess that among the BaYeke the shaman simply attends the mining and smelting, prepares the sacred medicines and directs the purely ritual details; that the chief, if he is a member of the "copper eating" guild, presides over the whole business; and that the master smelters are any experts or prominent members of the guild who run furnaces of their own.

BaIla

Ila (242)[5] smelting proceeds under the close supervision of an "iron doctor," whose rare knowledge is handed down from father to son, and who alone knows the secret medicines which are absolutely necessary for the process. He camps in the long shelter which the men build for themselves near the furnaces; selects a man whom he calls "wife" to cook for him and give him other assistance; and refrains from shaving or cutting his hair throughout the smelting period.

His first ritual act is to pour a pot of beer mixed with medicines into the four holes which have been dug for the furnaces. When the furnace walls have been built about a foot high, a boy and girl are put within, and the iron doctor gives them each a bean which they must crack between their teeth and swallow. The cracking of the bean symbolizes the crackling of the smelting fire; and incites the men to shout joyfully "It crackles within!," forecasting the proper smelting of the iron. Having been brought into such close association on an occasion so grand, the boy and girl should later marry.

The iron doctor does most of the packing of the furnace. He prepares for this weighty business by retiring alone into the bush, where, with wide-staring eyes, he chews certain herbs which he later spits on the ore. But these are not the only magical substances which he adds to the charge. Pieces of hippopotamus hide, guinea-fowl feathers, and a number of secret things are also necessary; and seem to play a sympathetic magical part — the cries of the hippo and the guinea fowl being identified with the loud harsh noises in the smelting furnace. Atop the whole charge the doctor places obliquely some split pieces of a mystic wood. When the iron has been extracted he retires to his permanent dwelling, shakes his rattle, and sings.

The iron doctor's supernatural functions rather obscure his purely technical ones, but the latter become obvious at several points. It is he who packs the charge,

5. 242: Vol. 1, pp. 202-21.

and who, by repeatedly examining the inside of the ventilating tubes, says when the smelting has been finished.

So much for shamanism. But let us return to the sexual aspects of Ila iron-smelting, which are particularly well developed. I have mentioned the iron doctor's "wife," the man who not only cooks for him but helps him to charge the furnace; and the boy and girl who crack beans between their teeth within the unfinished furnace wall. These are only slight suggestions of the sexual associations of smelting, both positive and negative. Throughout the whole period the workmen live in their special shelter and observe the strictest sexual taboos. One visiting the village must refrain from copulation, may not even sit on his bed or enter his house; and all women in the village are in the condition of recently bereaved widows, who must not wash or anoint themselves or wear any ornaments lest they tempt the smelters. Though women prepare the fine clay for the ventilating tubes, no menstruating women may come near the smelter's camp. If one of the men has a wet dream while sleeping there, he must be purified by sitting under a small leafy bower on a cross-roads, while the doctor sprinkles him with special medicines; and must then run along one road, through the bower, and along the other, thus leaving the defilement behind. Anyone transgressing any of these taboos, or failing to be purified, is said to have bewitched the iron and made the smelting a failure. Several trivial prohibitions seem to have no sexual reference: the taboo on water for men while building the furnaces, the exclusion from the foundry of anyone wearing a dark cloth, black or dark things being generally unlucky.

As on many occasions when sexual activity is taboo, lewd jests and poetry are encouraged. Smith and Dale give the following songs sung by the men during smelting; adding that "all adultery, in fact everything <u>but bad language and stealing</u>," is taboo to the doctor and the workers — a restricted sort of license which finds a striking parallel in the circumcision schools of Southeast Africa.

"Kongwe [clitoris] and Malaba the black [labiae feminae], Kongwe horrifies me: Kongwe and Malaba the black, Kongwe horrifies me! I found Kongwe blowing the fire. Kongwe horrifies me.

"Pass away at a distance, pass away far, — you whom we had repeated connection with; pass far away, pass far away, — you whom we had repeated connection with, pass far away.

"Bring the pole to the orifice of the ventilating tube; there is cleansing medicine there!

"O doctors, we are going, we are going off with them, we are going to get medicines. Let their child stay and see whether the kiln will tell him it is boiling.

"The man with the bare glans, it's all split, it has become of the spring, it makes him defaecate.

"O man with the bare glans, pass far away; this little work belongs to the smelters; a glans which would strike you in the eye must not be brought here.

"Oh, it is boiling, it is boiling, the medicine; when this physic is ready I shall free a woman and a child; it is boiling, the medicine.

"You who curse the smelters! Your clitoris is grown tremendously, your labiae will be hoes with which you can cultivate your grain.

"There is work to the smelters, there is work, there is work; to those who quarry the stone, there is work. Yes, you find the footprints of the stones, you begin to rejoice. Children of the doctor tell it out, they have returned home who bewitched the stones."

The smelting fire seems to have a supernatural value of its own. It must not be called fire, but "the fierce one" — a sympathetic term which induces it to burn more fiercely.

Ila smiths inherit their profession through the father, and the ethnographers imply that most or all of the smiths belong to one clan, the Bene Lubulo. They are always liable to the suspicion of witchcraft "because of the little things which they forge," and protect themselves against this suspicion by means of certain medicines Their forge is a favorite gossiping place for men.

The extensive use of smelting medicines has parallels in Katanga usage nearby, and among the far-away Fangwe; the smithy as a gossiping place recalls Chagga usage; and the two children within the unfinished walls are semi-counterparts of the juvenile pair who carry the smelting medicines in Ufipa, as now to be described.

In Ufipa (307), on the southeastern shores of Lake Tanganyika, smelting and refining of iron take place in the dry season, from May to November, and are controlled by a group of specialists, asirungu. This group apparently includes the hunters' guild, for hunters perform much of the labor of smelting and receive in reward a definite proportion of the yield.

Four supernatural factors operate to make the smelting a success or a failure. These are: (1) the purity or impurity of the workers; (2) the ancestral spirits; (3) the special power of the master smelter; and (4) the medicines. The ancestral spirits and the medicines seem to function quite independently, though both demand that those who

labor be ritually clean. The power of the master smelter depends largely on his possession of good medicines.

This master, in choosing the men, women, and children for the season's work, eliminates all those who he believes are impure: those, for example, who have eaten pork during the past year, or those who have had adulterous relations, or men whose wives have committed adultery. Having thus selected his crew, he orders them to build the furnace and the smelting camp. The sexual division of labor is about the same as in normal economic activities, men doing most of the heavy work with pick and axe, women working with clay; but at one point a breach of the ordinary rule causes a moment of awkwardness. The tuyeres are thought too technical matter, or too intimately connected with the smelting mysteries, to be entrusted to women. Though made of clay — women's material — they are fashioned by boys, who are so ashamed of this effeminate occupation that they perform it at some secluded spot in the bush where nobody can watch them.

The preparation of the charcoal is a very delicate affair. For this, new axes must be made, and all the hunters and professional assistants who will cut the wood leave their axes to "sleep" in the chief's hut for the night. On that night all members of the group must abstain from sexual intercourse. Over these axes the master smelter pronounces a curse on anyone who will curse them, and evokes the protection of the ancestral spirits. The next morning all the participants smear white earth on their foreheads as a mark of purity, and go forth with their axes to cut the wood.

On the evening before the departure to the smelting camp, the master smelter brings out his ntangala, the box containing his special smelting medicines — a weird assortment of bones, feathers, skins of poisonous snakes, and so on — which he keeps on a special shelf in the place of honor in his hut, and handles with the greatest reverence. Having placed this on a stool, he kneels before it and worships it as his master; then spits on it, asking that a blessing fall on him just as his spittle falls on the box. All the workers then file past it, kneel, and receive another smear of white earth on their foreheads. As they leave the hut they give cries of joy to acclaim the powers of the ntangala. Next morning, before sunrise, they solemnly proceed from the village to the smelting camp, led by two young children who have as yet had no sexual life. One of these children carries the ntangala, the other a cock and a hen for sacrifice. Both must "walk as spirits," without touching or scratching themselves.

Once the workers have established themselves in the smelting camp, the women burn the wood to charcoal and bring the charcoal to the furnace in baskets woven specially for this occasion. If the charcoal-burning fails, someone violated a taboo on the night when the axes were blessed. If he confesses, he is excluded from the camp and must pay a fine of twenty goats or a slave. If no one confesses, poison ordeals may be administered to any suspects; or a diviner may declare that an evil ghost is causing the trouble. The bones of the trouble-maker must then be exhumed and burned.

The next critical point is the planting of the medicines in the pit beneath the furnace floor. Here the two innocent children again serve in a place too perilous for adults. They bring the ntagala and the chickens to the furnace, again "walking as spirits;" cut the chickens' throats and sprinkle their blood over furnace, tuyeres, wood, ore, and charcoal. One of them takes the ntagala into the furnace while the other stays outside, both repeating to an annonymous spirit, "Light the fire yourself! May it burn well!" Following the directions of the master, the child within the furnace places the medicines in the pit, adding the heads of the two chickens and covering all with earth. Master and children then return to the smelting camp, where children alone may eat the sacrificial fowl, while the feathers, bones, and other debris are carefully buried.

Ceremonies likewise precede the refining of the iron. The master again worships his ntagala; but instead of slaughtering a chicken to draw blood, he simply breaks its toe, mixes some of the blood with his medicines, and then, with closed eyes and mouth, sprinkles blood on the crucible walls. He places the mixture of medicines and blood in a little clay vessel which he seals with clay in the bottom of the crucible. The chicken he kills and eats without any ceremony when the work is over.

In November, when the big rains are about to begin, the master gives the order to break camp and return to the normal village. The whole crew rejoices in a great beer party, the wives of the smelters presenting them with special beer which they alone may drink. On the evening after the return, the master places the ntagala on a stool, bows down to it and claps his hands in homage, followed by all of his male assistants. The sacred vessel and its contents are then returned to their shelf, and everybody gets drunk.

Before using a new smithy, the Fipa smith kills a cock and sprinkles its blood on the anvil, "That this forge may not spoil my iron! That it may bring me riches and fortune!" He then chants a prayer to his ancestors, cuts off the chicken's wings and hangs them on the frame of the hut as a protective charm. After this, he and his professional friends eat the chicken.

Analogies to the smelting ritual of this last group of tribes occur among the Lamba of the same region, and among the Pangwe, BaGanda, Lugwari, WaNyamwezi, Northern BaTetela, and apparently most Congo peoples,

who taboo sexual intercourse during smelting; and among the ALunda and BaKaonde of the Kasempa District, Northern Rhodesia, who intimately associate iron smelting with the spirits of the dead. Both of these features, however, seem to be general for the Congo and as far to the northeast as the Fangwe. Another widespread similarity is the association of smiths with hunters. We find this in Darfur and Wadai, where smiths and hunters are socially degraded; among the BaHoloholo west of Lake Tanganyika, who rate smiths socially just below chiefs and hunters; and possibly among the Masai, though hunters are here a different tribal group. "Medicines" are important to smiths among the Ababua and Safwa, and to smelters among the Fangwe, ATonga, Angoni, and some other peoples of the Nyasa-Tanganyika Plateau.

All of these features — sexual taboos, association with ancestral spirits, with chiefs, and with hunters, and the use of smelting medicines — seem to place the smelting-rituals of the Nyasaland-Katanga area in a broad relationship with those of the central forest, from the Fangwe on the northeast to the ATonga on the Zambezi.

Ondulu, Angola

To judge from our very fragmentary notes on the social and religious aspects of metal-working in Angola and the Southern Congo, the people of Ondulu (217) in Angola provide a typical example. Here blacksmiths form a hereditary guild, the members of which enjoy a social status about equal to that of shamans, and are led by masters who are often called ocimbanda, witch-doctor, as well as ocivinda, blacksmith. A youth born into this guild achieves professional status only by a long and difficult apprenticeship.

The master smiths always direct the smelting. During the whole smelting period, which usually covers the last five months of the dry season, the men and boys sleep in a circle of huts built around the furnace, where the women bring them their food. They lighten the work by continual choruses and intervals of dancing, but any breach of rules during this time, either by males or females, is punished by a fine.

So far the picture contrasts sharply with that of the BaKitara. But a curious analogy appears in the treatment given the smith's sledge-hammer, which is made by experts for each novice in return for a large pig. When the hammer has been finished, the women brew great quantities of beer for a feast, and the hammer is sprinkled with the blood of a sacrificed fowl. It is then tied by a cloth on the back of a young girl, just as a babe is tied on the back of the mother; and is thus carried to its owner's village, accompanied by the chief blacksmith, his assistants, their relatives, and the whole population of the village where it was made, all singing special songs. But instead of being merely child, as among the BaKitara, the hammer is here also called "chief" or "mother." By providing hoes for the fields it feeds the people, just as the chief, through his connection with the fertile earth, is responsible for plenty; and it nourishes the people as a mother does her child. When travelling, its owner never takes it into villages, but sleeps with it in the woods; for when a chief has visited a village as an overnight guest the women may not work in the fields the next day.

Ovimbundu

Hambly's data on the Ovimbundu (113, 114)[6] fail to give us many points of comparison with the patterns described above. Though this group rate smelting very high among industries, their smiths do not form a hereditary caste and are not endogamous. They do, however, attach considerable value to the great hammer, have to undergo an elaborate apprenticeship and initiation, and are affiliated with spirits in a rather extraordinary way.

The apprentice begins his training at about eighteen, but is not allowed to make implements till he has been initiated two years later. His master then examines him, makes the tools which he will use in his calling — the symbol of the skill transmitted to him — and conducts the initiation ceremony. For this occasion the novice purchases two cocks and two hens, a puppy, and a goat. The ritual centers chiefly on the making of the large hammer. After the master has welded the head to the handle, and while the hammer is still red hot, he pushes the handle into the belly of the dog; then kills the goat and the chickens and sprinkles the new tools with their blood. He and his assistants eat the sacrificial meats with maize and beans. The novice has been standing all this while on a small anvil, and the master now says to him, "You may speak and tell us what name you want." When the novice has announced his choice, the bystanders clap their hands and trill with their fingers in their open mouths. Then the young man steps down from the anvil a full-fledged blacksmith.

Ovimbundu smiths attribute some of their skill to the spirits of people whom they have killed, and represent these victims by wooden effigies set up near the large anvil or in their own dwellings.

The District of Lake Leopold II and the Lukenie River

The Mosengere and BaSakata, the only two tribes around Lake Leopold II and the Lukenie River from whom we have good accounts (171), seem to lack any specific re-

6. 114: pp. 158-61.

ligious practices in smelting or forging, and place most of the non-technical emphasis on the inheritance of the craft and the status of the craftsmen with relation to chieftanship. Tribes north of the BaSakata have a tradition that a few generations ago — apparently when an old informant's father was a child — an iron-working tribe entered their region from the north, paused for a while to mine and smelt and to trade their products to the Mosengere and other natives, and then passed southward toward the Lufini. Maes believes that these immigrants were the BaSakata. They are said to have possessed the special fetish for iron-working. No one could approach them while they worked; they "sang night and day," and the night sky glowed with their smelting fires. As they departed they burned all their huts and demolished all their forges and furnaces, leaving only broken bits of ore and other refuse. Though the Mosengere claim not to have had the fetish when the mysterious wanderers passed through, Maes does not state definitely whether special fetishes now function in local iron-working, and merely speculates that before this migration metallurgy was probably practiced by a special caste, the forefathers of the present chiefs, who possessed the necessary secrets and enjoyed social privileges.

Though the Mosengere and BaSakata do not invoke deities to assist them in smelting, they take certain measures against evil supernatural forces and to prevent laymen from viewing some parts of the process. When the master smelter is about to prepare the channel and the clay receptacle into which the molten iron will run, he sends all women and children back to the village, and he allows no one but himself in the hut while he is baking the furnace walls. During smelting, the workmen may leave the hut only to defecate or urinate, and may have no contact with the other villagers, especially no sexual relations.

Compared with some smelting rituals, this one seems quite featureless. But as I have said, these tribes identify smiths with chiefs, and watch the inheritance of the craft and of its accessories very carefully. All of their chiefs are blacksmiths, or at least have the knowledge and the right to be. Though Maes does not explicitly say so, I think we may assume that the master smelter is also the master smith. At any rate, the master smith is usually the founder of the village, around which several smaller settlements may be set up by smiths and their families from the old community.

The dignity of the master smith is embodied in his bellows, which he will sell only for a very high price. He is usually the only individual who owns a bellows privately, and since its quality and the number of its chambers are correlated with the prestige of him and of his group, he takes the greatest care of it, and repairs it many times before retiring it from use.

Another prerogative of the master smith is to make iron anvils. Only he knows the secret of their manufacture and may guard the axe with which he incises their flat heads, and only he may use one as a hammer. He also makes the iron hammer, as well as all iron insignia carried by people of rank. Among the Bokala and Ipala, smiths have the right to wear the national coiffure. Smiths of the Mosengere, Tumba, and Wadia are graded according to their rights to manufacture certain objects, the value of which determines the smith's prestige. With this high social position of smiths are connected the iron — and sometimes copper — insignia worn by different ranks of chiefs. Among the BaNkutshu of the Bena Dibele area, cloth makers take the place of smiths in the social scheme, but this is probably a recent modification due to southern and possibly to Arab influence. Even Mosengere and Sakata smiths, however, engage in wood-carving and the manufacture of wearing apparel, in addition to their work in metals.

The smith is also subject to several restrictions, being usually forbidden, for example, to forge iron in a village other than his own. His full-fledged assistants may collaborate in making everyday weapons and tools, but novices may work on iron only till the form of the object begins to appear, and must leave the subsequent strokes entirely to the initiates.

Though the smith may take on apprentices, his craft is primarily a hereditary affair. Its inheritance follows both the paternal and maternal lines, in a rather complicated manner. All male children of a master smith may learn his profession, their father making their tools and being responsible for their technical education. At his death, however, his forge and equipment pass not to his sons but to the oldest son of his sister who is nearest him in age, if possible to the oldest son of a sister born immediately after him. If the dead smith has no sister, his inheritor will be chosen from among his brothers, with whom his sons will continue as apprentices; or, in default of living brothers, from among the sons of their daughters. If the smith dies without sisters' sons, brothers, or brothers' daughters' sons, his forge ceases to be used.

In addition to the inheritor designated above, the smith admits to his professional secrets all male children of his uterine sisters and, for a remuneration, forges their tools from iron which they bring to him. To his own children, however, he gives a more careful <u>education</u> while they work as apprentices at his forge, and from them he expects no remuneration for making their tools. A new master smith is assisted by his brothers and his father's sisters' sons, who are all mere novices, and rarely by his mother's brothers' sons, who may be full-fledged smiths. He is obliged to continue the education of his brothers toward full professional status, but not to care for his cousins in the same way.

Theoretically, therefore, the new

smiths tend to form a more numerous group than those of the dead smith's generation; but in practice the sons of the dead smith usually gather around themselves a few relatives and malcontents and hive off to establish a new village and smithy. The rightful inheritor, however, alone has the right and obligation to make tools for this new shop, and he is theoretically the parent chief of the new village. A smith's sons may, with their father's consent, leave his village and establish forges of their own during his lifetime. The father then has all rights at the new forges, but shares the profits of the work with the sons. Though he may make their tools, he must do so at the new forge. The sons of a dead master smith, upon completing their education under his inheritor, regularly leave to found a new forge and village; but they can never again cooperate at the parent forge or expect their father's inheritor to work at theirs. The mother's brothers' sons of the master smith, however — though they may assist at the new forge — have no right to leave the old village, and only there can they handle the smith's hammers.

Thus we find repeated, among blacksmiths in the central Congo, the same old African story of the hiving off of new kraals from the parent community, with the authority of the parent chief formally maintained; and in addition,a specific Congo feature,the matrilineal inheritance of rank.

The partial identification of smiths with chiefs is manifested in a number of other groups in the Congo area: notably on the upper Ogowe, where smiths are always sorcerers and often chiefs; in Loango,where the national sacred fire is tended by a priest-smith; among the BaSonge, where smiths rank immediately after chiefs; among the BaHoloholo, where they rank just below chiefs and hunters and above the chief's lieutenant and shamans; and among the BuShongo, who claim that smithing was revealed in a dream to Woko, the fourth king in their long royal line, and who point to several kings of old time who were famous smiths.

This close connection between smithing and chieftanship in the Congo may account for the situation among the BaKaonde,ALunda, BaUshi, and BaYeke on the Congo's southeastern borders, where the ancestral associations of smelting seem to have remained, though the specific identification of smiths with village chiefs is apparently never made.

North of the Congo, the ancestral aspects also persist, while the taboos of the smelting period are more stringent and the smelting "medicines" play a greater part.

Pangwe

Four factors make Pangwe (269)[7] iron-making more than a technical affair: the fire cult, the ancestral cult, a belief that the nature of plants can exert a sympathetic magical effect on the products of industry, and a still more general conviction, widespread throughout Negro Africa, that sexual activity of any sort may cause the work to go wrong. Pangwe attach no social stigma to the craft, and the iron-workers enjoy no special position other than the respect for their skill, for their ability to foot the high shaman's fees and the physical difficulties of the work, and for the large profits which they receive.

Though the smith usually works in the village club house, on demand five men or a few more contribute to the building and upkeep of a special smelting hut, where smelting, in each working period, is performed as many times as there are owners of the hut, so that each one can receive the major part of a bloom.

For two months before smelting, as well as during the process, the smelters must abstain from sexual intercourse. Near their workshop they may build a small dormitory, where they can pass the night free from temptation. If one of their wives is menstruating, they incise a lozenge-shaped pattern on one of the posts opposite the furnace, smear it with a powdered red wood which she has given them, and cover it with a leaf of <u>Myrianthus</u> <u>arboreus</u> to hide the shame.

Plants whose compactness or flexibility may induce these qualities in iron, play a large part in both smelting and forging. Most of the "medicines" bought at a high price from the shaman and deposited in a pot, basket, or wooden vessel, which is buried in leaves in a little chamber beneath the smelting pit, are chosen on this principle: bark shavings of <u>Macrolobium</u> <u>straussianum</u> <u>Harms</u>, whose heavy, plank-like roots will cause the bloom to lie heavy in the pit; leaves of <u>Marattia</u> <u>fraxinea</u> <u>Sm</u>., to make the iron compact like the young fronds of this fern. The panicles, leaves, and stems of the burry <u>Plectranthus</u> and <u>Aneilema</u> <u>aequinoctiale</u> <u>Kth</u>., deposited under the smith's anvil, express the wish that the small bits of iron may stick as closely together as do the fruits, leaves, and stems of these plants. The smith may throw a couple of <u>Plectranthus</u> fruits into his tuyere for the same reason. The chicken killed and eaten by the smiths is cooked in leaves of <u>Anystasia</u> <u>macrophylla</u> <u>T. And</u>., <u>Manotes</u> <u>zenkeri</u> <u>Gilg</u>., <u>Diospyros</u> <u>fragrans</u> <u>Gurke</u>, <u>Desplatsia</u> <u>dewevrei</u> <u>Burset</u>, the tough and flexible stems of which will impart the same qualities to the iron. A similar motive may influence the choice of wood for the smelters' charcoal, which is that of especially "strong" plants: <u>Pentaclethra</u> <u>macrophylla</u> <u>Benth</u>., <u>Erythrophloeum</u> <u>Guineense</u> <u>Don</u>., <u>Cylicodiscus</u> <u>gabunensis</u> <u>Harms</u>., <u>Eurypetalum</u> <u>tessmannii</u> <u>Harms</u>., and <u>Irvingia</u> <u>grandifolia</u> <u>Engl</u>., though here the physical advantages

7. 269: pp. 224-39.

may outweigh the magical ones.

Ancestor worship and the fire cult are also strongly associated with Pangwe metallurgy. Only men who stand high in these cults can poke the smelting fire. From time to time during the smelting the shaman strikes between the bellows with a bouquet of Rinorea gracilipes Engl. or Bandeiraea tenuiflora Benth., bringing the power of the ancestors to bear against any unseen evils that may be lurking about. Tessmann explains that these plants are chosen because their leaves are like those of the Copaifera tessmannii Harms., the dwelling-tree of souls in limbo, or are used when Copaifera leaves are unobtainable. Since chickens are associated with the fire cult, their feathers comprise the essential ingredient in the mixture of "medicines" buried beneath the anvil, and a chicken is killed and eaten by the smiths, who cook its flesh with the tough, flexible herbs I have named above.

The shaman does his best to give the bellows-workers strength and to drive evil spirits from the scene. He leads the rhythmic hissing, and rushes around the workers blowing on an antelope horn, ringing an iron bell, singing, crying, and urging them to action. When they have just stopped their work, he makes before each bellows-boy two motions — one as if he were placing something in the furnace through the tuyere, another as if he were dropping something in at the top of the furnace, his assistant standing behind him holding an animal tail.

The Pangwe practice of burying a pot of "medicines" in a pit beneath the smelting furnace reminds us of a similar rite in Ungoni (97),[8] where the pot is covered by a lid perforated with four holes, then surrounded with broken clay flues, and the whole deposit roofed over with clay.

Fouta

Now let us turn to West Africa, where the high development of secret societies, trade guilds, and the ancestral cult has not failed to affect metal-working. In Fouta (84) smiths inherit their work from their fathers, just as do all other craftsmen; but they also form a despised, endogamous caste, not only because almost all of them are descended from captives brought from Bouré (Siguiri), but because they are always suspected of sorcery and of affiliation with secret sects, and because a smith betrayed the Prophet Muhammad to his enemies and was consequently cursed.

But laymen sometimes make use of the smith's magical powers, such as when they swear oaths on his anvil. In this rite the smith invokes his ancestors to kill the breaker of the oath, and the contracting parties, having each placed a rice cake and a kola nut on the anvil, and holding their right hands on it, loudly pronounce the oath. They and the smith then eat the kola nut and the rice cakes, still holding their hands on the anvil.

Iron mining in Fouta is highly ritualized, an exception to the common lack of ritual in despised smith castes. At the full moon during the dry season, smiths' families isolate themselves in the bush, where they all make a systematic search for good laterite. Having found a rich deposit, they gather in a copse at sunrise to sacrifice to the local spirit. Sitting at the foot of the largest tree, their oldest smith offers a white chicken, seven round rice cakes, and seven kola nuts; he decapitates the chicken, holds it on the ground exactly where it fell, plucks it, and cuts it in half, still holding the lower half where it fell. He then throws the kola nuts and the rice cakes down beside the chicken and divides them in the same way. The upper halves of these offerings are then borne in silent procession to the ore deposit to be given to the spirit residing there. All the next night the smiths, arrayed in raphia fibre costumes with helmets of leaf, and hung with iron bells and with iron-ring rattles in their hands, dance in a clearing in the moonlight. The next morning they begin to mine the ore. The dances in costume are typical for secret societies in this part of West Africa, a scheme to which the ritual of iron-working has been adapted.

Tiv

The Tiv in Benue Province, Northern Nigeria (1),[9] stress a sort of metaphysical association between iron, stone celts, thunderbolts, and the cult of the dead. It is impossible to discuss this kind of a situation out of its complete social and religious context, and I mention it here simply as another example of the many ways in which metals may be ritualized. The Tiv consider iron a means of securing conjunction between the living and the dead. One of their cult emblems is a tuyere, which they employ in connection with iron in rites to secure the aid of the household ancestors and to ward off their displeasure. They ascribe to iron and to stone celts a certain magical power which flows through the smithy and through all associated objects, and manifests itself in thunderbolts. If a member of a secret society who uses his powers destructively enters a smithy, he is soon afterwards struck dead by lightning; and anyone who possesses smith's tools or iron slag, or who wears a stone celt on his person, automatically brings death by lightning on a sorcerer who tries to bewitch him. The Tiv swear oaths on the iron tools of the smith, probably with the same power in mind. Iron connotes power and prestige. A chief wears a pair of iron forceps hanging from his neck; and many

8. 97: p. 169.

9. 1: pp. 67, 139-40.

chiefs, though they do not engage in metal-working, keep a complete set of smith's tools. A man who aspires to prestige or who wants to become a smith must propitiate a certain agricultural cult emblem associated with iron and thunderbolts. In this rite the officiant sacrifices a hen and a cock which the candidate has provided, allowing their blood to fall on tongs, anvil, tuyere, and bellows, and touches the candidate on neck and back with some of the blood. The chickens are then ritually eaten. After this the candidate, if given the smith's tools, can begin iron-working without fear. If he omitted this rite, however, the cult emblem would punish him by pains in the back, sterility, and the destruction of his house by lightning.

Evhe

The Evhe of Togo (244) stress the hereditary aspects of the blacksmith's craft. Evhe smiths pass their vocation on to their sons and sons' sons; to their sisters' sons only if they have none of their own. They never take apprentices from outside the family, the sons working for their father without fee; and they believe that if a layman sets up a smithy independently he will die.

The smith's hammer enforces these restrictions by punishing impostors with sickness and death. Before the blacksmith's son can inherit the profession officially, his father consults the fetish priests in the god-house to learn whether the hammer will accept him. The priests divine the answer by placing flour on cowry shells and moving them around with appropriate invocations. A son whom the hammer refuses may practice no other trade, for the hammer would cause his work to fail. If the answer is favorable, however, the young smith is said to be bewitched by the hammer, and may follow his father's profession and teach it to his own son. If he took up any other craft the hammer would make him sick, and would require a sacrifice before he could be cured.

The Evhe smith calls his set of tools "the hammer and its relatives." At all fetish feasts given by the group, these godlings receive their due. The members submit to an ordeal by drinking water from a pot in which the hammer has been submerged, the hammer thus threatening death to anyone who has committed, but failed to confess, thievery, murder by poison, or some other offense within the group.

Every year the smith and his family observe a special holiday for his tools. He cleans them, sweeps his shop and courtyard, and sprinkles the tools with the blood of a sacrificial sheep, goat, or fowl. The flesh of the sacrifice is cut into small pieces, boiled, and mixed with maize porridge. The smith and his family eat this mixture, placing some on the tools, and on the ground at the entrance of the smithy as an offering to the ancestral smiths. After this they may not quench their thirst with plain water, since that would displease the gods;but with water whitened with maize flour, which they first pour as a libation on the tools and on the ground in front of the smithy. Some of the beer, palm wine, or brandy drunk at this feast must be offered in this manner. The tools punish the smith or his children if he neglects these rites.

The Evhe smithy is said to be normally immune to fire; and its conflagration portends a great calamity for the whole village.

The reader should look carefully over the following tabulated notes before considering my few final remarks on the social and religious aspects of metal-working.

Comparative Table

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
Western Sudan (9)	H: smiths attach themselves to chiefs; work evil for chiefs: act as chief's councilors; not killed or mutilated in war. D: despised also.	Caste endogamous; some members do not follow the profession	Feared for supernatural powers and dealings with evil spirits		
West Africa (74: p. 172)		All smiths form a caste			
Peul of Senegambia (31: pp. 143-44)	D: inferior caste	Usually "captives;" separate caste; often itinerant; endogamous	Smiths regarded as sorcerers		
	D: Laobes despised	Laobes do iron work; nomadic; came to country with Fulani; are wood-workers also; endogamous			
Senoufo (71: Vol. 1, pp. 263-66)		Smiths form separate villages or quarters of villages			
Liberia (101: pp. 56-57)	H: smith greeted respectfully; a public confidante and go-between; strong voice in council; plays a big part in secret societies	Smiths usually itinerant; work hereditary in proud families; long genealogies like chiefs'; get free farm labor like chief and shaman; wood-carvers belong to smith castes	Smith a master of ceremonies in secret societies; has supernatural powers		
French West Africa (Degougou) (94)		Hereditary guild	Magicians "because of skill in smelting from ore"		
Kpelle (304: pp. 35-36)	H: smith acts as go-between for marriages, quarrels, etc.	Smith always a member of the secret society, holds prominent place in it. Some smiths itinerant. Not paid for work he does for the chief. Exempt from war because he makes			After the clubhouse, smithy is favorite meeting place for gossip, etc.; erected by all villagers, hen then sacrificed, blood shaken around smithy, hen's bones hung there; smithy

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
		and repairs weapons			always at entrance of village
Agni-Ashanti group (266: pp. 44-45)	No special status, can marry anyone				
Agni (70)	No special status	Goldworkers separate profession. Smiths called by word applied to other craftsmen: not endogamous			
Ibo (15: pp. 171-76)		Iron-working only by certain towns; rigid "trade unionism"			
Ibo (262: Vol. 3, pp. 923-28; 263: p. 277; 274: part 1, pp. 129-30)	H: blacksmithing the most important craft	Guild ancient: secrets carefully guarded; apprentices usually taken from smith's own family. Awka guild were itinerant smiths, and also were agents for the Agbala juju (oracular); had to be in Awka for annual celebration of Ukwu		Sacrifice made before smith leaves on a working tour; shaman indicates where he shall go	Ibo blacksmiths famous; they travel far to work
Edo (275)		Brass workers organized, have a chief; usually live in one street; very specialized. Claim descent from kings of Ufe, one of whom married a brass worker's daughter. Boy apprenticed young. Blacksmiths not dependent on smithing for living		Sacrifice offered to Ogun, the deity of blacksmiths	Blacksmithing hereditary? Smithy a meeting place in heat of afternoon
Bambara (188)			Smiths are magicians. In traditional history, Massasi was a famous blacksmith magician who knew the language of the birds.	Magical rites in mining and smelting, only smiths take part; work naked and observe certain taboos	

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
			Raffenel saw a smith cure snakebite		
Kaarta (213: pp. 272-73)	H: iron-workers "command villages;" have even greater power than among Malinke				
Goundam (77)	H: Bankore town traditionally founded by a fugitive princess with the daughter of her blacksmith				
Goulla (Lake Iro) (56: p. 293)		Smiths are tanners also			
Habbe (78: pp. 368-69)		Special metal-working caste (noumou)			
Yatenga (264: pp. 218-19, 543-44, 554)	D: smiths somewhat avoided except in cercle of Wagadugu	Smiths not Mossi, but Foulse; Samo have their own. Endogamous. Samo smiths are also woodworkers; their wives are the potters. "Dabas" of Ouahigouya cercle have special reputation			A few Bambara smiths in Yatenga, taken there in the second half of eighteenth century
Foulouse (Yatenga) (264: pp. 543-44)		Usually in large family groups. Large household group split up into several "work groups," each under its headman, for agriculture and iron-working (as also among Mossi and non-smithing Foulse)			
Mossi (174: Vol. 9, pp. 718-19)		Smiths a separate caste, hereditary; jewelers are not		Mining and smelting secret	

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
Northern Nigeria (182: Vol. 1, pp. 149-51)	D: no stigma except among Kanembu				
Kanembu (182: Vol. 1, pp. 149-51)	D: despise all forms of industry				
Kanem (56: p. 402)		Iron workers a special caste			
Hausa at Kano (267: pp. 207-15)		Two kinds of metal-workers: (1) for iron; (2) for brass and tin		Secret antidotes to keep fire from burning smith; can be magically nullified by enemy smith	
Munshi (Northern Nigeria) (182: Vol. 1, pp. 155-56)	H: highly reputed	Initiation necessary			
Birnin Gwari district (Northern Nigeria) (182: Vol. 1, pp. 149-51)		Temporary settle-ments of Maguzawa smelt and make hoes for local Hausa and Gwari			
Koro (Northern Nigeria) (182: Vol. 1, pp. 149-51)		Used to smelt; now all smelting done by itinerant Jaba from Sokoto, who give present to Koro chief in return for mining privileges			
Angas (Northern Nigeria) (182: Vol. 1, pp. 149-51)				Religious chief starts charcoal-wood gathering by cutting down certain trees	
Mbarawa (Northern Nigeria) (182: Vol. 1, pp. 149-51)				Women do all mining; men see-ing them are seized and fined.	

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
				Before mining, libations of beer to tutelary genius in sacred grove to aid mining	
Bagam (173)	H: smiths very influential tradesmen. Brass caster ranks as attendant to chief; gets all orders from him	All trades under direct control of head chief. Guilds restricted to small membership. Chief iron-worker is also a wood-carver		Ceremony before allowing stranger to enter smelting hut: he is sprinkled with infusion of m-vun leaves; presents fowl to master smelter, its legs tied with yayap creeper; visitor takes it in left hand to furnace; its throat cut and its blood sprinkled on top of furnace; everyone in hut then eats piece	
Baya-Kala (272: pp. 166-87)				After 2 handfulls of ore put in furnace, chicken beaten over furnace, bellows, hut-posts, etc., 5 small feathers plucked and stuck in hole in front of furnace; owner of furnace does this; from now on only he may touch furnace; chicken said to bring good luck to smelting	
Southern Baya (272: pp. 166-87)		Anyone allowed to smelt iron; pays		Ward off sorcery from smelters:	Smelting hut in village; center

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
		fee to owner of furnaces. Only professional woodcarvers can make bellows		sprig of *Erythrophloeum* with chicken wing stuck in roof of smelting hut; also sprig of certain euphorbia (*Antidesma venosum*) tied to central post. *Erythrophloeum* tree gives poison for ordeal for suspected sorcerers	for other men's industries too
Bogoto (Baya) (272: pp. 166-87)		Fee to expert for introducing smelting technique into village of another sib; he may marry the daughter of the new smelter at a knock-down rate. Arrangements cheaper if two men are of the same sib. Client gets iron cheaper if he assists in smelting		Less "medicines" than among Pangwe. Fragment of old smelting furnace stuck high on pole; smelting place may be a sanctuary against theft. *Anona senegalensis* not brought into smelting hut "because it smells bad;" great fear lest drop of rain fall on furnace	
Mandja (100: pp. 225-32)	H: smiths respected only for their superior economic position	Smiths the only professional class of artisans; live at mines			
Ababua (111: pp. 233 ff.)	H: very respected	Profession not necessarily inherited	Magical powers by virtue of the "medicine" the smith possesses		Ore has a supernatural dangerous quality, can be handled only by smiths
Upper Ogowe (73)	H: smiths are often chiefs		Smiths are sorcerers	Smelting at night, for "great fetish of the country comes to	Smithy the "social center"

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
				help." Master smelter yells and beats hammer on anvil during smelting	
Loango (205: Vol. 3, sec. 2, p. 170)	H: priest-smiths		Priest-smiths		National sacred fire tended by priest-smith
BaNgala (197: pp. 181-82; 297)	H: smiths important, have unique place in community; honored for skill, not feared	Iron-working the only specialized profession except boat-making and sorcery. Learned by apprenticeship to father or village blacksmith. Smith taught trade only to son or nephew?	Shamanistic powers	Forbidden to step over, blow into, or spit into the furnace; would pollute the fire	
BaYaka (283: p. 350)	H: not degraded, skill respected	Smiths not a special class but their profession is hereditary			
BaSonge (198: p. 223 ff.)	H: respected, rank first after chief	Profession hereditary from father to son			Every village has two or three smiths
Northern BaTetela (283: pp. 135-36)				Sexual inter-course taboo during mining and smelting	
Olemba (BaTetela) (283: p. 135)	H: smiths respected		Smiths are shamans		
Bushongo (282: pp. 193-96)	H: iron-workers much respected; Bope Pelenge the traditional chief smith	No caste	Iron-workers have magical powers		
BaMbala (280; 283: p. 350)	No social distinctions	Smith teaches his trade to his sister's son; latter inherits his tools			Smith dies if he parts with his hammer
BaHoloholo (233: pp. 117-18)	H: smiths rate below chiefs and hunters,				

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
	above chief's lieutenant and shamans				
ALunda (Kasempa district) (184: p. 137)				More intertwined with spirit-worship than among BaKaonde; apparatus and techniques too sacred to change; change would anger spirits; these apparently spirits of the dead	Every part of apparatus sacred
BaKaonde (184: pp. 136-37)				If father's spirit is adverse the ore turns to water and not iron; smelters avoid women during smelting, but this taboo is not connected with spirits	
Lamba (80: pp. 347-51)	H: highly honored and lucrative profession; many chiefs learn smithing	"Bond of friendship" between all smiths		Sexual intercourse taboo before and during smelting	Women forbidden in smithy
Darfur and Wadai (287: pp. 351-52)	D: inferior, just as are hunters; people avoid them. Must give a metal article to a sherif whenever latter passes (in Darfur)	Endogamous			
Mangbetu (199; 57: Vol. 2, pp. 129-30)	H: highly respected; chiefs attach blacksmiths to themselves	Smiths live apart; craft hereditary from father to son			Every village has its blacksmith
Jur (61)	H: smiths respected		Oaths sworn on anvil of dead smith are inviolable		

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
Lugwari (181)				Smelter avoids wife during smelting	
Kuku (210: pp. 181-84)		Certain families; usually rich in livestock from fees; spend much time with agriculture and stock raising		Small termite hill topped with 4 chicken feathers, near furnace to give luck to smelting	
Latuka (260: p. 794)	H: smith an informal authority on village affairs	Profession hereditary			Smithy a favorite gathering-place for men
Bari (240)	H: smiths admired for skill D: smiths an inferior class but do not admit it	No marriage restrictions; smiths can acquire cattle but are distinct from the "true cattle-keeping Bari." Live in separate villages under chief of district. Sometimes in ordinary villages, but work outside	Probably none	Women present at iron-working; sing to encourage smiths at their work	Breaking smith's tools is magical damage. Blacksmith's wife plays ceremonial part in mourning rites. Iron used in preventing and curing sickness, and in rain-making
Lango (82: pp. 86 ff.)	No social privileges or disabilities	Iron workers and ariko ornament makers form guilds like drum makers; work usually inherited from father to son			Inviolable from theft and trespass
Labwor (296)	H: respected	Profession hereditary			Smithy and smelting house not stockaded, because respected
Akikuyu (227: pp. 79-97)		2 out of the 13 clans can never work iron; one of these 2 does not circumcise. No guild. Blacksmiths the only highly skilled craftsmen	Curse of smith especially "biting and adhesive," expensive to get rid of	Smelting not ritualized	
Somali (202: pp. 236-37)	D: despised caste (tomal)				

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
Chuka (195: pp. 129-31)			Smiths gifted in magic		
WaNyaturu	H: respected	Smiths professional			Women forbidden in smithy
BaNyamwezi (34: Vol. 1, pp. 161-65)					
WaNyamwezi (central or western) (261)				Smelters work naked; taboo sexual intercourse, salt; their women stay in village and say men are travelling. Before working, smiths smear elbows with bean soup and sing "Look here!"	
WaKonongo (S. WaNyamwezi) (256: pp. 152-63)				While preparing ore and charcoal, smelters taboo bathing, sexual intercourse, honey, milk, butter, fish, salt, seasoning. Women help smith bring charcoal to smelting place	
Safwa (145: pp. 180-82)				Medicinal plants buried beneath anvil. Prayer to ancestors; libations of beer on anvil. Boring of "eye" of hammer is dangerous; done at night; only few have the right medicine	
Tanga Coast (21: pp. 232-33)					Smithy is clubhouse for youths of village

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
Ruanda (62: Vol. 1, pp. 155-58)			Good at procuring abortion; play big part in ceremonies; head of royal smiths prominent in court ceremonies		
BaGanda (224: p. 381 ff.)	H: kings and chiefs have their own smiths	Profession usually inherited by son		Smelters isolated during smelting. Smith's son learning smithing is "confirmed in his work" by father jumping over mother after mother has put away the first iron tool made by the boy	
Suk (24: p. 18)	H: "God gave them no sheep so he gave them brains instead"	Only poor agricultural people		Women must not see smith work lest he go mad and die. Prayers and chants during forging	
Nandi (124: pp. 36-38)	D: treated almost as equals	Generally endogamous	Smith's curse on thief fatal. Client spits into hand before touching a new iron object	Women forbidden smithy and to watch smiths work. Pray to God (Asis) while hunting ore	Anvil never parted with
Elgeyo (179: pp. 50-51)	D: despised caste	Separate caste; patrilineal; endogamous; if smith marries outside caste his wife's brother will die			Smiths not allowed to hold stock because if they got rich they would stop working
Konde (167: pp. 148-49)	D: feared and ridiculed		Smith a source of power; in constant touch with spirit world		
Nyasa-Tanganyika Plateau (97: p. 170)		Only a few families have the right medicine for smelting		"Crocodile gall" the medicine necessary for	

Comparative Table (cont'd)

Culture	Smiths honored (H) or despised (D)	Caste and guild aspects	Supernatural powers	Ritual of work	Remarks
				smelting; sexual intercourse taboo during smelting	
Manyanja (137: p. 141)					Bellows used therapeutically to pump air into wounds
Ungoni (97: p. 169)				Pot of medicines with broken tuyeres buried under smelting furnace	
Atonga (97: p. 170)				Piece of after-birth thrown into iron to further smelting; strangers forbidden smelting hut during smelting	
BaVenda (255: p. 60)	D: contempt and fear toward BaLemba iron-workers				
BaHurutse (122: pp. 241-48)		Some or all copper-smiths are not iron-workers			
Kafir (Natal) (55: Vol. 1, p. 6)	H: highly respected; especially brass-smiths; live near chief	Profession inherited patrilineally; brass-working a secret craft			
OvaMbo (154: Vol. 2, p. 195, 203-204)	D: low class families, though important; called by derogatory term	Smiths itinerant, endogamous			
Hottentot (230: pp. 315-16)		Smiths probably not professional			

GENERAL REMARKS

The mere geographical distribution of traits like these means very little. They do not move about like dots of various colors on an otherwise blank map of Africa. The low rating of smiths and hunters in Wadai and Darfur, for example, may have no historical connection with the association of these two professions in the Congo and Rhodesia; and we should not connect the Pangwe practice of burying "medicines" beneath the smelting furnace, with a similar usage among the Angoni of Nyasaland, until we have studied the cultural background in each case, and have found a continuous geographical distribution, and a well nigh unbroken time-sequence, from one to the other. Even if these data were available, such a quest would lead us into religious and social realms far beyond the scope of this paper. We can observe that a despised smith caste and a lack of smelting ritual characterize the northern grasslands of East Africa; that trade guilds, sorcery, the association with secret societies, and the smithy-clubhouse are common among metal-workers in West Africa; that in the Congo forest and its borderlands to the south and east we find the association of smiths with chiefs and hunters, complex smelting rituals in which "medicines" and spirits play big parts, and a smelters' guild rather than a smiths' caste; and that secrecy, sexual taboos, the personification of hammer and anvil, and the inheritance of the profession, are likely to occur almost anywhere. But beyond these simple observations, riddled as they are with exceptions, we cannot at present venture.

We must admit that in the mind of the Negro metals may possess an inherent mysterious quality, either by virtue of their hardness and brightness when found in the native state, or because of the miraculous transformation effected at smelting. We have seen how the Natal natives, in the late eighteenth or early nineteenth century, attributed an epidemic to a new kind of metal which had become the fashion for chiefs; and how the offending material was not only buried, but those who had discovered and worked it were condemned to death. A curious analogy occurs among the Mangbetu, who have probably found small lumps of native platinum, but have always superstitiously feared and avoided them (199).[10] The widespread use of the Bantu word for shaman, or one of its cognates, to denote a smith or smelter, has been advanced as an argument for the inherent magic of the smith's craft. But when we examine individual usages we find that this term simply denotes the skill which is necessary for shamanism, metal-working, and a number of other professional occupations. Thus the Kongo word for smith is ngangula — from ngangu, meaning cunning, art, craft — whereas the word for doctor or sorcerer is nganga (134)."[11] In Natal the term inyanga (99) means medicine man, smelter of iron or copper, blacksmith, oxhide worker, basket maker, or anyone practising an occupation in which much skill is required.

I cannot believe that the mysterious quality of metals accounts for the rituals described above, or that the latter express an original division of the population between immigrant and indigenous peoples.

In Negro Africa as a whole, hunting is ritualized as much as, if not more than, metal-working, as illustrated by the identification of hunters' guild and "copper-eaters'" guild in the Katanga, and the rating of smiths just below chiefs and hunters among the BaHoloholo. Metallurgy, like hunting, usually requires considerable skill and is an occupation from which, because of the Negro emphasis on agriculture or cattle-raising, most of the community is excluded. Though an extremely necessary one, providing the weapons and implements for sustaining life, its long and arduous practice tends to isolate the smith, either seasonally or throughout the year, from the very social and economic activities which his efforts sustain. We have seen what effects this may have on the social position of smiths among tribes such as the Masai, who identify one particular occupation — cattle-raising — with all that is noble. Blacksmiths thus form a despised caste not so much among peoples who are ruled by pastoral aristocracies as among tribes who conventionally devote themselves to cattle, or who despise all forms of manual labor. They have the most elevated position in the Congo and West Africa, particularly in cultures where other arts and crafts are well developed.

The negative correlation of smelting and smithing rituals with special metal-working castes stands out very clearly in the notes presented above, and suggests that both ritual and caste are conditioned by the general cultural frame, rather than by the wonderment of Primitive Man at processes which he fails to understand.

10. 199: pp. 265-71.

11. 134: Vol. 2, pp. 805-806.

XIV. SPECULATIONS

Some of the older generation of anthropologists still think largely in terms of origins, and consider an ethnographer's work unfinished until he has talked of parallels, convergence, concentric distribution, and so on, or has indulged in fanciful reconstructions which cover up the gaps in his historical or archaeological data. For them I append the following guesses, an anticlimax after so much hard labor, hoping that when Negro archaeology has offered us real information on metals, my colleagues will forget that I ever made assumptions which no facts known at the time could justify.

We should not assume that the African Iron Age was everywhere preceded by an extensive use of stone. Primitive sylvan hunters, such as the Pygmies, can eke out a fairly good set of weapons and implements from shell, bamboo, hard woods, and wood hardened in the fire; and may, as do the Gabun Pygmies, live in humus-covered areas where loose stones are rare. I do not mean to suggest that any pre-metal culture entirely lacked stone implements, but that these may have been very few and simple, and that iron may have been adopted suddenly by peoples who had derived their chief materials from plants and trees.

Between the pure Neolithic and the stoneless industries prevailing throughout Negro Africa today, there intervened, at least in Northern Nigeria and the Western Sudan, several centuries in which both iron and stone were used. This mixed inventory seems rare or absent throughout much of the central forest region, indicating perhaps an abrupt transition to iron; but it appears again in Mumbwa Cavern in Northern Rhodesia, where many stone implements seem to have been deposited after iron had been smelted.

The Negroes of the Western Sudan learned to smelt iron about 400 A.D., when the first waves of camel-riding Berbers put them in indirect touch with northern civilizations. At first, however, no northern techniques came in; the Negroes developed their own. The art of smelting did not reach the forested coastlands of Guinea until relatively late, and then only in certain districts; but it spread quickly through the Central Sudan and down into the Congo basin, carrying with it a simple but thoroughly effective forging technique, with drum bellows, a nail-shaped iron anvil, and a straight unhafted iron hammer which would be used as an anvil as well. These rudiments eventually diffused through the Congo to Rhodesia and Nyasaland, eastward to the Upper Nile and the Lakes, and even to a few points along the coast of the Indian Ocean. In tropical West Africa and the Congo, the same artistic and industrial stimuli which raised wood-carving, pottery, and weaving to such heights, made the blacksmith's craft an esthetic as well as practical achievement.

Metal-working did not spread across Africa as a single broad front, but as many divergent and interlacing streams, some fast and some slow, which at first left several Neolithic islands. The Congo, for example, as the scene of bewildering migrations and many differences in cultural level, shows the most varied metallurgical histories, iron-working being old among some Congo peoples, new among others, and transmitted in many different directions. Only within the last few centuries did tribes in the northeastern Congo pass the secrets of the industry on to those living west and north of Lake Victoria, Urundi learning metallurgy from the north scarcely more than two hundred years ago. From the southern Congo it diffused eastward into Unyamwezi, but failed to reach some tribes east and south of Unyamwezi until the last few generations.

Over most of the Negro area the smelting technique remained the same: fine wrought iron produced under a hand-forced draught in a simple pit or hearth. Sometimes the smelters increased their yield by building over the pit a small clay furnace, two or three feet high, charged with layers of ore and charcoal, but still they had to work the bellows throughout the smelting and produced only small quantities of wrought iron. In two widely separated areas, however — the interior of West Africa, west of the Niger's middle course; and the interior of Southeast Africa, from the Congo-Zambezi watershed east to Lake Nyasa and south to the bend of the Kafue River — iron smelting became a big industry, the furnaces grew taller, and free ventilating tubes were substituted for bellows.

Natives on the southeast coast first learned of iron from Arab or Indian traders about 600 A.D., and passed the knowledge of metal-working south and west to inland groups who had not yet received it from northwestern sources. It filtered into East Africa from the northeast as well, but it did so more slowly here, for the Ethiopians and their neighbors lacked the adventurous trading proclivities of the Arabs, and there were no great local sources of copper, tin, and gold.

The first foreign contacts were stimulated by this quest for gold, which the Negro thus learned to value. They set in motion the importation of copper into the Su-

dan from the north and the discovery of large copper and tin deposits in the Southeast. These mines were dug by Negroes to supply an Asiatic market, and some of the work was done under foreign supervision. Tin from Northern Nigeria met the brass and copper brought across the Sahara to West Africa, to produce a casting art which reached its esthetic culmination in the brasses of Benin. It is near the gold fields of the Western Sudan and Southeast Africa that we find special casting techniques (cire perdue in the northwest, rod casting in the southeast), early copper alloys, and apparent centers of diffusion for the bag bellows, jointed tongs, wire-drawing, hafted hammers, and other foreign elements. With the exception of casting and alloys, similar innovations were entering the northern grasslands of East Africa from the Ethiopian region.

In two cases, techniques were transferred to iron working from the more valuable metals: Yoruba, where the resmelting of selected iron clinker imitated Northern Nigerian tin working; and the Southeast, where the use of crucibles and smelting fluxes for iron was taken over from copper working.

In the long story of Negro metallurgy Egypt played but a negligible role. Neither the Egyptians themselves nor the Negroes living near them have ever been leaders in the craft. Iron-working seems to have arrived in the Lakes region from the west or southwest in relatively recent times, and Nilotic groups like the Shilluk, who have no iron sources of their own, import the metal from the south rather than from the north. None of the higher technical achievements — blast furnaces, alloys, wire-making, the cire perdue, and the finer forms of bellows, anvils, and hammers — center in regions adjacent to Egypt, but reach the height of their development in parts of the continent where no early Egyptian contact can be demonstrated.

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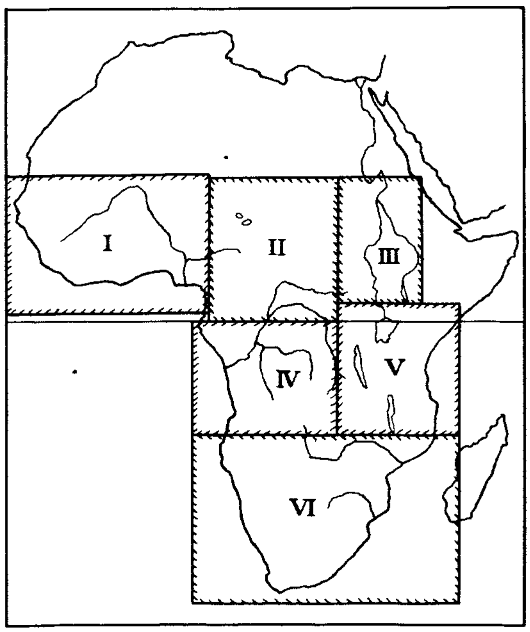
SECTIONAL MAPS OF AFRICA

Showing Situation of Tribes and Localities



Africa - Key Map

SECTION I

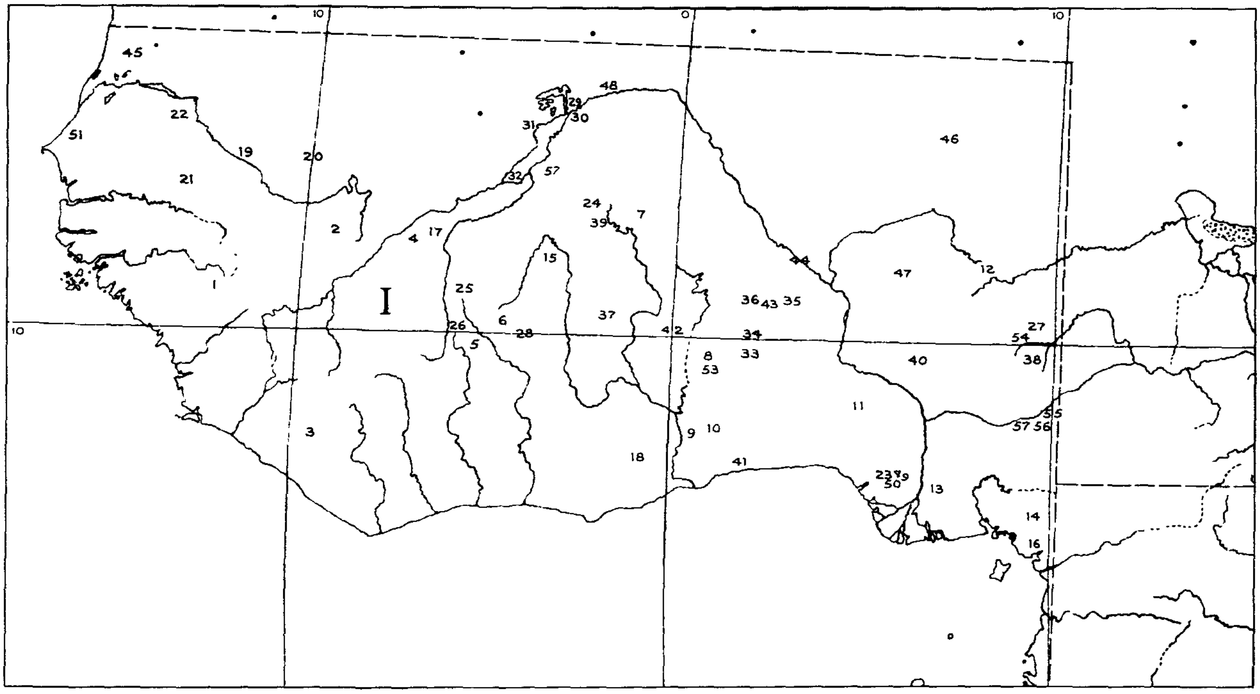
1. Futa Jallon
2. Bakoy River, etc.
3. Kpelle
4. Bambara
5. Senufo
6. Banfora
7. Gourma
8. Basari
9. Akpafu
10. Atakpame
11. Yoruba
12. Kano
13. Ibo
14. Ossidinge
15. Dedougou
16. Bakwiri
17. Kamalia
18. Ashanti
19. Bakel town
20. Kaarta district
21. Bondou district
22. Futa district
23. Edo
24. Yatenga district
25. Kourala town
26. Tengrela town
27. Liruen town (Hausa)
28. Dorhosie
29. Goundam
30. El Oualedji
31. Sumpi
32. Gourao
33. Kabure
34. Losso
35. Sugu
36. Grunssi
37. Lobi
38. Angas
39. Mossi
40. Nupe
41. Ewe
42. Dagomba
43. Borgu
44. Dendi village
45. Moors
46. Gobir
47. Sokoto
48. Timbuktu
49. Benin city
50. Gwato
51. Joloff
52. Habbe
53. Tschaudjo
54. Sangawa
55. Ibi
56. Jukun
57. Munshi

SECTION II

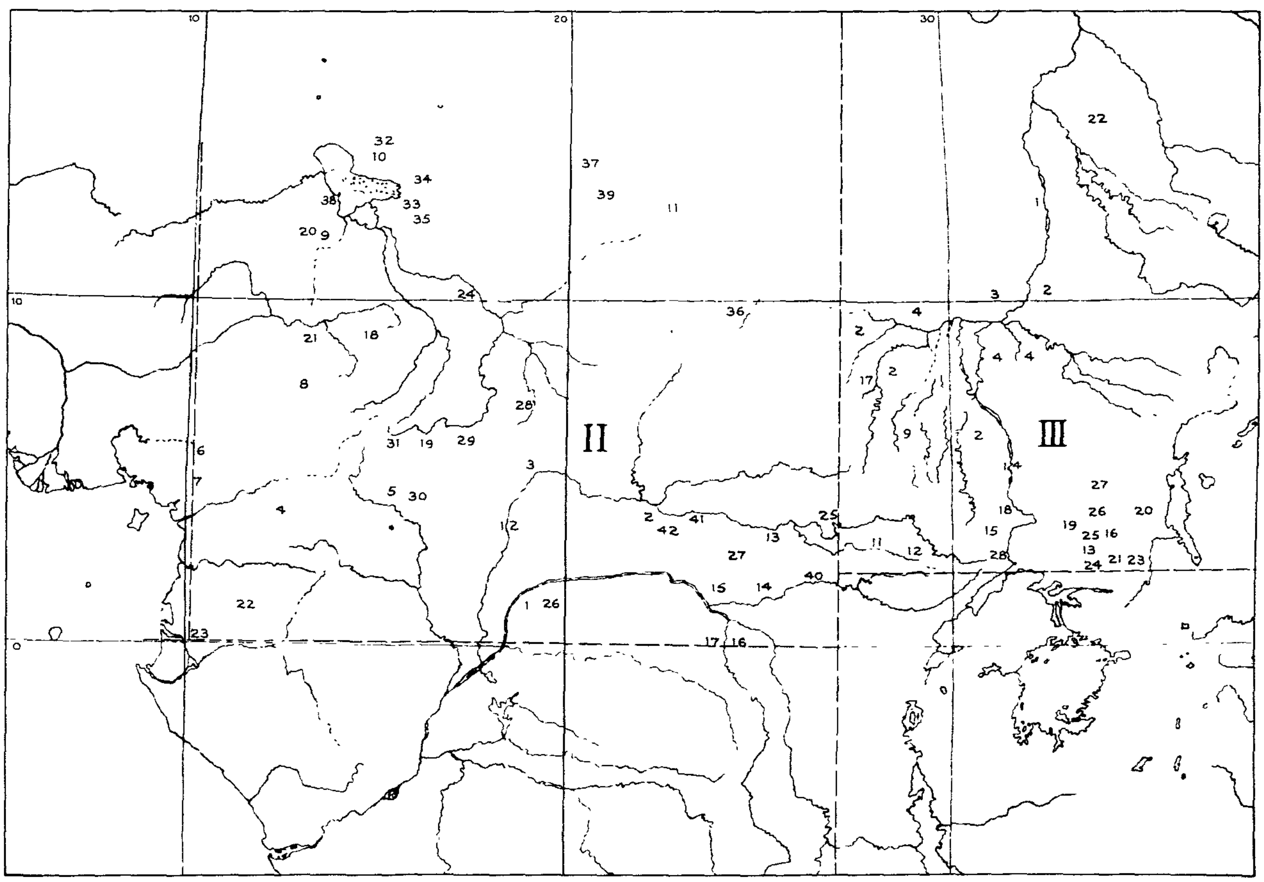
1. BaNgala
2. Bongo (?)
3. Mandja
4. Jaunde
5. Baya
6. Bagam
7. Bakundu
8. Namtschi
9. Marghi
10. Wandala (Chittati)
11. Darfur
12. Busembe
13. Ababua
14. Babongoro, Banganjoro
15. Basoko
16. Lokele
17. Topoke
18. Bubandjidda
19. M'baka
20. Bornu
21. Tschamba
22. Fang
23. Fangwe
24. Goulla
25. Amadi town (Abarembo, Mangbetu)
26. Lulanga River
27. Bokiba
28. Gribingui River
29. Bogoto (sub-tribe of Baya)
30. Baya-Kaka, Baya-Buli
31. Baya-Kala
32. Chittati
33. Dagana
34. Dar Kreda
35. Khozzam
36. Hofrat en Nahas
37. Nimro (Jellaba people, Wadai)
38. Kuka
39. Wadai
40. Gaza
41. Mobalia
41. Djabir
42. Bobwa

SECTION III

1. White Nile
2. Dinka
3. Shilluk
4. Nuer
9. Bongo (?)
11. Momfu
12. Mangbetu
13. Tobur
14. Bari
15. Lugwari
16. Karamojo
17. Luo ("Jur")
18. Kuku
19. Acholi
20. Turkana
21. Tororo Hills
22. Senaar
23. Karamojong (cf. also No. 16)
24. Labwor
25. Jie
26. Dodotho
27. WaNdorobo
28. Aluru



Section I. West Africa.



Sections II and III. Cameroons, Northern Congo, and East Africa.

SECTION IV

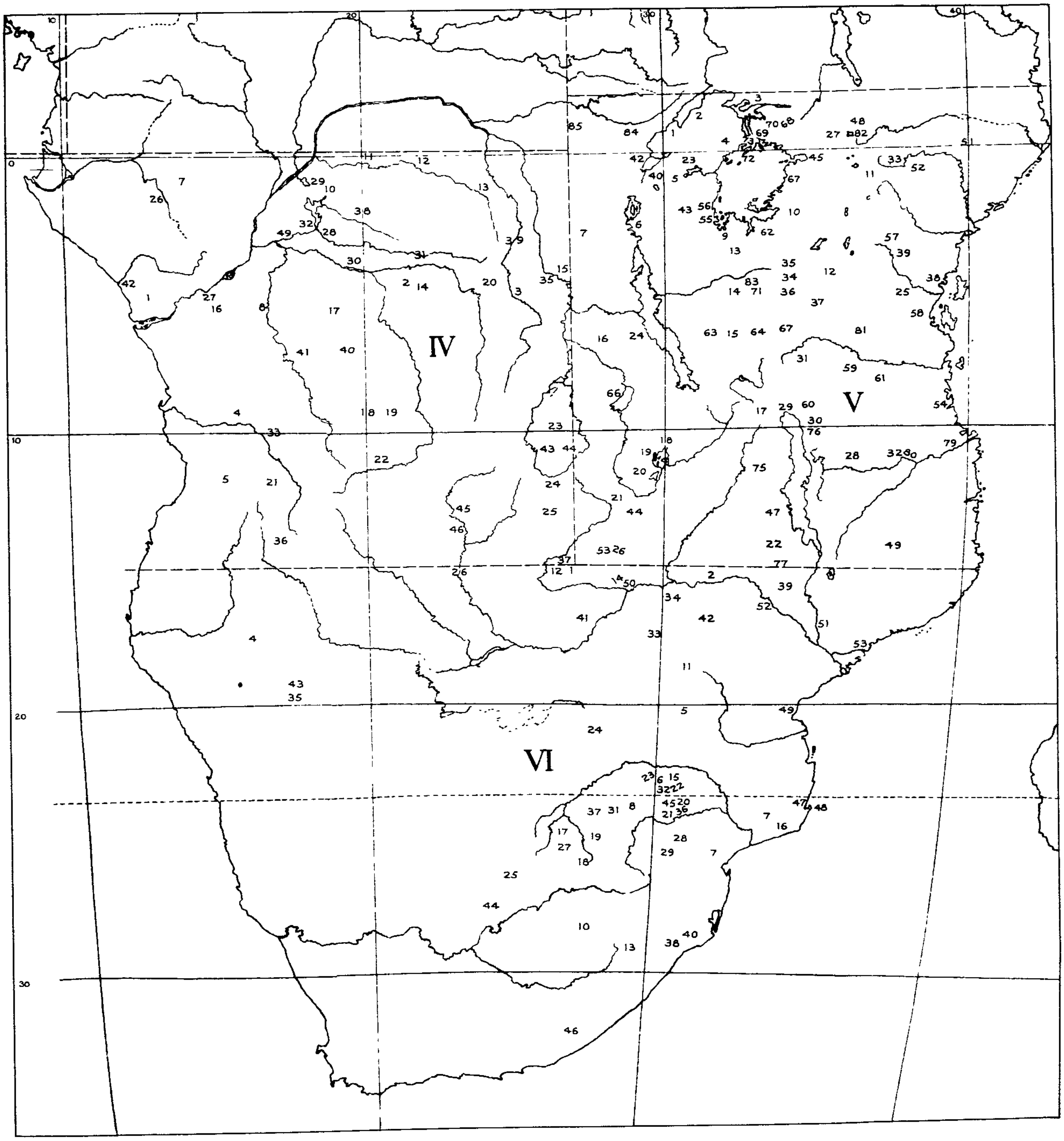
1. Mayombe
2. Bushongo
3. BaSonge
4. Massangano (Lucalla River)
5. Ovimbundu
7. BaTeke
8. BaYaka
10. BaYanzi
11. BaLolo
13. BaFoto (Bopoto?)
14. BaKuba
15. Manyema
16. BaKongo
17. BaMbala
18. BaKioko
19. A-Lunda
20. BaTetela
21. Ondulu
22. BaChokwe
23. Katanga
24. Ksanshi
25. BaKaonde
26. Upper Ogowe
27. Manyanga
28. BaLesa (Tolo district)
30. BaNkutu
31. BaSongo-meno
32. Wadia
33. Ngolo
35. Nyangwe
36. Ganguella
37. BaLuba
38. Ipanga
39. Akela
40. BaPende
41. BaNgongo
42. Loango
43. BaSanga
44. BaYeke
45. Saloisho Hills
46. Shinte's BaLunda

SECTION V

1. WaKondjo
2. BaKitara
3. Lango
4. BaGanda
5. Karagwe
6. BaRundi
7. WaRega
9. Usindja
10. Masai
11. Akikuyu
12. Irangi
13. WaNyamwezi
14. WaNyamwezi
15. WaNyamwezi
16. BaLuba
17. Konde
18. BaWemba
19. BaBisa
20. BaUshi
21. Lamba
22. Angoni
23. BaNyankole
24. BaHoloholo
25. WaSambara (WaTschambaa)
26. BaTwa (Broken Hill district)
27. Nandi
28. Ungoni
29. WaNyika
30. WaKinga
31. Ussangu
32. Lindi hinterland
33. Chuka
34. WanIramba
35. WanIssansu
36. WanyaTuru
37. WaSandawe
38. Tanga Coast
39. WaPare
40. Mpororo
41. Safwa
43. Ruanda
44. Bwana Mkuba
45. Kavirondo Bay
47. Angoni of Nyasaland
48. Suk
49. WaMakua
51. Galla
52. Akamba
53. BaLenje
54. WaChinga (at Kilwa)
55. Kiziba
56. Kissaka
57. Kibosho (on Kilimandjaro)
58. WaZegua
59. WaHehe
60. WaBena
61. WaPogoro
62. WaSukuma
63. WaKonongo
64. WaKimbu
65. WaGogo
66. Lake Mweru
67. Shirati (WaGaia and WaSuba)
68. Bukedi
69. Jinja (in Busoga)
70. Samia Hills
71. Tabora
72. Bugaya Islands
73. Buvuma
74. WanItumba
75. WaHenga
76. WaNgindo
77. WaMangandja
79. Newala
80. Mt. Ssengwa
81. WaSagara
82. Elgeyo
83. Unyanyembe
84. WaVira (BaBira)
85. Babali

SECTION VI

1. BaIla
2. BaSenga
4. Ovambo
5. Zimbabwe
6. BaVenda
7. BaThonga
8. BaLemba
10. BaSuto
11. Mashona (Charter district)
12. Mumbwa
13. Cathkin Park
14. Lusaka
15. Messina Mine
16. VaChopi
17. BaGatlha
18. BaKuena (Magliesberg)
19. Kooi-Berg
20. Murchison Range
21. Leydsdorp
22. Klein Letaba
23. Messina
24. Francistown
25. Wagon Drift
26. BaRotse
27. Pilandsberg
28. Pilgrimsrest
29. Lydenburg
31. Pietersburg
32. Spelonken
33. "Alaska" property
34. Tete
35. Otavi
36. Mashishimali Hills
37. Agatha
38. Amatikula River
39. Anyanja (Marawi)
40. AmaZulu
41. BaTonga
42. Karanga
43. Tsumeb
44. Kuruman
45. Palabora
46. AmaXosa
47. Inhambane
48. Cape Correntes
49. Sofala
50. Fungo Hills
51. Lower Shire River
52. Sena
53. Quilimane



Sections IV, V, and VI. Southern Congo, Southeast and South Africa.

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Metallurgy – Soil [illegible]

Mining — " "

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